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ABSTRACT

A new physical science course was introduced into Western Australia's upper secondary schools in 1978. The major focus of this document is a description of the implementation of the course and its materials during the first two years. Following a brief introduction and overview, chapters focus on: the establishment of physical science as a tertiary admissions examination subject including the rationale for introducing the physical science course, production and dissemination of course materials, academic backgrounds and initial perceptions of physical science students, implementation procedures within schools including initial and on-going inservice programs, student and teacher perceptions related to course materials, and a final chapter highlighting the major points of the document. Ancillary material, such as statements from colleges relating to physical science, is provided in appendices. (SK)

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CO-OPERATIVE RESEARCH SERIES No. 8

FINAL PHYSICAL SCIENCE EVALUATION REPORT

A PROJECT CONDUCTED JOINTLY BY THE WESTERN AUSTRALIAN INSTITUTE OF TECHNOLOGY AND THE EDUCATION DEPARTMENT OF WESTERN AUSTRALIA

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EDUCATION DEPARTMENT OF WESTERN AUSTRALIA

SE 036 438

FINAL PHYSICAL SCIENCE EVALUATION REPORT

MUREDACH B. DYNAN
ANTHONY S. RYAN

A project in Curriculum Evaluation
conducted jointly by the Western Australian
Institute of Technology and the Education
Department of Western Australia

Co-operative Research Series
Report No 8

Education Department of Western Australia
1981

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7. Secondary School Homework

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FOREWORD

This report, the second from the project to be published in the Co-operative Research Series, marks the completion of the formal study of the new Physical Science course. Since the course was first introduced on a pilot basis in nineteen schools in 1979, the number of adopting schools has grown to a total of forty-eight in 1980. Through its careful documentation of the field trials, and through its continuing and close interaction with the writing team, the evaluation project has had a major influence on the refinement of the materials prepared for the Physical Science teachers and students.

A co-operative venture between the Institute of Technology and the Education Department of Western Australia, the evaluation was carried out by a team led by Mr M B Dynan and Dr A S Ryan of the Institute's Centre for the Study of Teaching. Special adviser to the project during the period of the study was Dr D J Boud, now with the Tertiary Education Research Centre, University of New South Wales.

This report describes the development and implementation in schools during the first two years of the new Physical Science subject, presenting and interpreting the views and reactions of those closely associated with the innovation. It also presents data on student characteristics and enrolment patterns in this period.

I would like to thank the evaluation team for the thoroughness and sensitivity of the approach taken throughout the study and for the genuine co-operation which developed between the project and the curriculum developers. I believe the study has not only made a very successful contribution to the production and validation of the materials produced for the course, but at the same time has provided a readable and insightful account of the development processes used. The report should serve as an important resource not only for those who may be involved in subsequent revisions of the Physical Science materials but for curriculum workers generally.

My special appreciation is extended to Dr L Foster and Dr J de Laeter, who represented the Institute on the project's management committee, and to Mr K Betjeman, Dr N Hoffman and Mr J Puzey of the Education Department for their continuing contribution to the work of this committee.

D. Mossenson

DIRECTOR-GENERAL OF EDUCATION

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Consultant to the Evaluation Project

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PREFACE

This report marks the end of the Physical Science Evaluation Project and is intended to present, in a summative fashion, the major issues arising from the introduction of the new subject in Western Australia, its development and early implementation during 1978-79. We hope that the description and interpretation of these issues are of value to those closely involved with the innovation, though it is important to emphasise that many of the issues discussed here have already been responded to by curriculum developers, teachers and others during this formative period of implementation. For those not involved with the innovation, the report should provide a fuller understanding of the course, its rationale, structure and early implementation in schools in Western Australia.

For our part the ongoing, developing relationship between the processes of implementation and evaluation was a rewarding and satisfying experience. In that regard we are grateful to the curriculum developers and the teachers of Physical Science for their co-operation throughout the period of the project. We were aware throughout the study of the responsibility to represent fairly the views of all participating and interested groups. This we have attempted to do both in informal feedback to the Education Department personnel responsible for implementing the course and in formal evaluation reports. It has not been our role to make judgements about the appropriateness or worthwhileness of various viewpoints or actions, but to represent, in an holistic fashion, the perspectives held by those most closely involved.

Within the evaluation team we would like to acknowledge the special contributions of a number of colleagues over this two-year period. These include:

- David Boud who played a major role in establishing the model for evaluation and acted as the consultant to the project.

- Lesley Parker who, as the only full-time member of the team in its first year, made a vital contribution in planning the study and in the data-gathering and analyses leading to a number of evaluation reports.

- Jill Barrett and Kathryn Norris who contributed in very significant ways to the continuation of the project's work in its second year.

In relation to the many reports prepared by the evaluation team, special thanks are owed to Cheryl Hough of the Centre for the Study of Teaching whose typing and compilation skills were generously given. Finally, we wish to express our appreciation to the Management Committee representatives from the Education Department and WAIT whose advice, guidance and support facilitated and encouraged us in our task.

Muredach B Dynan
Anthony S Ryan

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CHAPTER 1: INTRODUCTION AND OVERVIEW

1.1 BACKGROUND TO THE REPORT

Preparation of this report began as the first group of students to complete the Physical Science course were about to sit for the 1979 Tertiary Admissions Examination (TAE). It was therefore an appropriate time for the evaluation project to provide a picture of the implementation of the course in Western Australian schools during the preceding two years, and to bring together the perspectives of participants on a range of issues surrounding its introduction. A number of evaluation reports have already been released by the project to a wide audience including teachers, tertiary personnel and other interested parties (See Appendix 1). Of these, two are particularly relevant to this report. One report[1] described the implementation during 1978 of the new course and examined a number of issues which had been important to students, teachers and others involved at that early stage. It also contained an outline of the evaluation study and of the approach used, and discussed the methods of data-gathering and reporting employed. These aspects are not repeated in the present report, although some discussion of the purposes and style of the report is included for clarification. The second report[2] examined the characteristics of those students who entered the course in 1979 as the second cohort and included some comparative data relating to the first cohort who began in 1978.

1.2 PURPOSES AND STYLE OF THE REPORT

The purposes of this report are twofold. The first is to describe the implementation of the new course and its associated materials during 1979. The second is to provide an illuminative account

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1 Physical Science Evaluation 1978, Co-operative Research Series, No. 3 Ed. Dept. (WA) 1980

2 Characteristics of 1979, Year 11 Physical Science Student Population, Ed. Dept. (WA), 1979

of the major issues and concerns that were seen as relevant by the various groups participating in the innovation.

The content of the report reflects the study's primary focus on issues related to the implementation of Physical Science in the schools. Emphasis is given to the perspectives of teachers and students who have been involved with the course over the first two years. Issues raised in the earlier report "Physical Science Evaluation 1978" are re-examined in the light of the experiences of participants in 1979. In structuring the report, we have found it convenient to divide the development and implementation processes into three phases. The first of these covers the period of early discussion and consultation leading up to the agreement on the basic outline of the course and the presentation of this to the Tertiary Admissions Examinations Committee (TAEC) and the Board of Secondary Education (BSE) in 1976. The second phase involves the period of development and production of the trial editions of the written materials for the course. The third phase concerns the period of dissemination of the course and its implementation in the schools up to the end of 1979. This reflects the scope of the evaluation project which was planned to cover the period prior to entry of the first cohort of Physical Science students in the Tertiary Admissions Examination.

The evaluation approach used in the study has derived largely from the principles of illuminative and responsive evaluations advocated respectively by Parlett and Hamilton (1976) and Stake (1975). Accordingly, the report seeks to interpret holistically the relevant events and perspectives and to represent, in a non-judgemental way, the variety of views expressed by participants. The style of the report is qualitative and descriptive. While statistics are included from time to time, they have been used mainly to underline or to support the qualitative picture presented.

CHAPTER 2: THE ESTABLISHMENT OF PHYSICAL SCIENCE AS A TERTIARY ADMISSIONS EXAMINATION SUBJECT

2.1 RATIONALE FOR INTRODUCTION OF THE PHYSICAL SCIENCE COURSE

Throughout the initial stages of exploration, consultation and negotiation which led finally in 1976 to the acceptance of Physical Science as a TAE subject, the Education Department of Western Australia was the prime mover. Other groups and institutions acted largely in response to the initiatives of the Department. Though some of these groups subsequently made crucial contributions during the process of defining the new subject and during the subsequent development of written materials for it, the idea for the course was conceived within the Education Department partly in response to changes in retention patterns in the upper secondary years. It had become clear by the early 1970s that an increasing proportion of Year 10 students were choosing to continue beyond the Achievement Certificate and that there was a need to provide new science courses more suited to the increasing numbers who were not oriented toward tertiary studies in Chemistry or Physics.

> *Overall, there was a need to react quickly to the changing demography and changing aspirations of students, so that the U.S. decline in physical science students was not mirrored in Western Australia...A much broader range of ability is now shown by students staying on in Years 11 and 12. There is a need for alternative non-elitist science courses.*
>
> *- Education Department Officer*

There was another aspect, however, which motivated the Education Department. In Western Australia, Chemistry and Physics, in conjunction with Mathematics II and III, have traditionally occupied a special position in the upper secondary school curriculum. These four subjects (sometimes referred to as the 'big four') were perceived by students to be of critical importance for entry to prestigious professions such as Medicine, Law and the Sciences (including Engineering) and it had been customary for a high proportion of the most able students to study

these subjects for the last two years at school. Since the number of subjects ordinarily studied in the final two years was six, of which English was compulsory, it was evident that many of the more able, tertiary bound students had little flexibility or opportunity for personal choice in the subjects studied. A relatively small proportion of these students continued their tertiary studies in chemistry or physics. Education Department personnel expressed concern with the consequent limitations of subject choice imposed on many upper-school students intending to proceed to tertiary studies in areas other than pure science. This concern was shared by many high school teachers and some tertiary personnel.

> *The most able segment of the High School students is channelled into the 'big four'. This is hard to justify since major decisions today are being made by economists and lawyers and such like. So why channel our best people into science and maths.*
>
> *- Education Department Officer*

2.2 CONSULTATIONS REGARDING THE PHYSICAL SCIENCE COURSE

The earliest suggestion of a new physical science matriculation subject came from a committee of Education Department Science Superintendents, Senior Masters of Science and Curriculum Officers which met in 1972 to examine the types of science courses offered in upper schools. It was envisaged by this committee that such a subject would be suitable for students who did not plan to take major tertiary studies in either chemistry or physics. Discussions at that time between Education Department personnel and representatives of Chemistry and Physics departments of the University of Western Australia and the Western Australian Institute of Technology did not produce any agreement on the need for such a subject.

In 1975 a document entitled "Survey of Upper Secondary Science Education in Western Australia", published by the Education Department, analysed data in relation to changing school populations in the State and examined trends in other states and overseas in relation to science curricula in secondary schools. This report concluded that there was a need to provide both a matriculation Physical Science course for tertiary

bound students and an integrated science course for non-tertiary bound students. Following wide circulation of this report, the Education Department established two committees to examine proposals arising from the needs identified. The major body known as the Secondary Science Education Curriculum Committee (S.S.E.C.C.) included representatives of the Education Department, Government and Independent schools, the State School Teacher's Union, the Teacher Education Authority as well as senior science academics from the University of Western Australia, Murdoch University and the Western Australian Institute of Technology. The second group, the Secondary Science Education Advisory Panel (S.S.E.A.P.), consisting of practising teachers from Government, Independent and Technical schools, was asked to provide advice and assistance to the S.S.E.C.C. in the latter's deliberations. After much debate it was finally agreed by the S.S.E.C.C. that a course leading to a tertiary admissions examination should be designed and presented for acceptance to the Board of Secondary Education and the Tertiary Admissions Examination Committee. It was further agreed to recommend to tertiary institutions that the new subject be included within the same group as Chemistry and Physics for purposes of determining admission of students to these institutions. However, it was accepted that students wishing to pursue tertiary courses in the physical sciences or in engineering would continue to be advised to study Chemistry or Physics in their final two years at school.

There was also agreement that the syllabus and structure of the new course should be based broadly on the approach taken by the one-year course 'Man and the Physical World' (1976) which had been developed in Victoria. Because of substantial modifications made by the S.S.E.C.C. to the content of that course, and the need for materials more appropriate to Western Australian schools, it was decided that written resource materials and teachers' guides would be produced by the Curriculum Branch of the Education Department. Eventually the proposed syllabus and an accompanying overview of the course were presented to the appropriate bodies; approval was granted for the new subject to commence in schools in 1978.

2.3 THE PHYSICAL SCIENCE COURSE

The course has three major aims

- understanding the physical world
- understanding science and the scientific process
- developing attitudes about science and the community

It includes five core units and six optional units from which students were originally expected to choose at least three[1]. The content of the course is related to three major conceptual areas, materials, energy and change and three themes are developed throughout. Though pure science is the predominant theme, continous emphasis is give to the supporting themes, applied science and cultural impact.

Although the course was designed on the basis that it should be as demanding conceptually as the existing TAE courses in chemistry and physics, it was not intended to have the same emphasis on quantitative treatment. It was also intended that Physical Science would provide an integrated coverage of chemistry and physics within a single TAE subject for those students who did not wish to study these two disciplines as separate subjects.

2.4 THE WRITTEN MATERIALS

For each core and optional unit of the course a resource book was produced for student use. Associated with each of these was a teacher's guide which incorporated all the content of the student book together with guidance on resources, teaching suggestions and the outcomes expected for each section. The purposes of the student resource books were to provide necessary information for student activities, include sample questions to guide students and indicate the depth of treatment intended for particular parts of the unit, and provide supplementary reading on aspects of the course which were not ordinarily

---

[1] It was eventually decided, in consultation with teachers in the first year of the course, to reduce this number by one.

covered in available chemistry and physics texts. Resource books were not intended to replace text books and students were advised to make use of relevant books and other references from class and school libraries.

Additionally, special case-study resource books dealing with particular industries were produced to assist classes with the industrial case-studies included in the Chemical Change and Science and Society units.

2.5 ISSUES INVOLVED IN THE ESTABLISHMENT OF PHYSICAL SCIENCE

In order to understand fully the nature of the course which emerged from the deliberations of the S.S.E.C.C. and some of the problems which later arose in the implementation of the course in schools, it is important to examine some of the issues which arose at the time. Two key groups in this context were the Education Department and the tertiary institutions, although the potential adopters -- the schools and teachers -- were also important participants and certainly were interested parties whose perspectives figured strongly in early planning.

2.5.1 Students for Whom the Course was Intended

> *You can't answer the question about target population. I'm not sure if it is the right question to ask. It is the students who will decide what the population is to be. Our job is to set the aims, content and standards of achievement for the course. We can set down the necessary pre-requisites. After that it is up to the students to choose.*
>
> *- Education Department Officer*

At the time the need for the new subject was first advanced by the Education Department, there was not the same enthusiasm for it among many of the academic staff in the tertiary institutions. Though the institutions ultimately agreed to its introduction, there remained mixed feelings about the course among some tertiary specialists. Moreover, though the "target" students for whom the course was designed were defined by the S.S.E.C.C., a degree of ambiguity persisted about

this particular aspect. Clearly the new subject was not designed for students with a weak background in science or mathematics. Indeed, it was expected that entrants would have attained above average Achievement Certificate grades in Year 10 Science and Mathematics. The Education Department took the view that, since students have the right to choose the subjects they wish to take, it would be unrealistic to attempt to define this population too closely in advance. Tertiary personnel, however, maintained that the kind of students for whom the course was to be designed should be specified clearly and publicly. In the event, the target population was defined as

> "(a) humanities-oriented students who wish to study some physical science simply to broaden their knowledge
>
> (b) science-oriented students who will not pursue careers in the pure physical sciences or engineering but who may wish to continue their studies in some applied science field[1]."

While this showed that Physical Science was not to be recommended for students aspiring to physical science or engineering at tertiary level, there remained considerable room for differences of perception about the suitability of the subject as a preparation for many tertiary courses. Individual institutions interpreted the appropriateness of the new course in somewhat different ways. Advice to schools from the University of Western Australia and the Western Australian Institute of Technology has been taken by most teachers and students to imply that Physical Science is not seen as a suitable preparation for most science-related courses at either of these institutions. Murdoch University was perceived as offering more flexible entry requirements, including

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[1] An Introduction to Physical Science, Curriculum Branch, Education Department (WA), 1978.

introductory courses, for those Physical Science students who wished to study science-related courses[1]. In practice, most schools have taken a cautious line by counselling students who are aiming for science-related studies at tertiary level to take Chemistry or Physics rather than Physical Science for the TAE.

Comments from Tertiary Personnel on Target Population

Physical Science should be for students going to Tertiary Institutions but not wanting 12 hours weekly at science...that is, for bright kids.

Do you risk putting a good Physical Science student into first year Chemistry. It is a problem -- there are such great holes in what they have done.

I saw the target group as non-physical science majors. A useful preparation for people going into Biology.

This Physical Science course is not what I thought it was going to be. I thought the intention was to produce a science course for those not going on to tertiary studies at all. The tragedy is, it is a matriculation subject.

This college regards Physical Science as of equal rank with Physics and Chemistry when dealing with its first Year intake into teacher training.

I never pictured us as having to take Physical Science students in this department. It doesn't follow that they should be allowed into Physics or Chemistry. It is a good subject if you are going to do, say, Architecture.

2.5.2 Possible Impact of Physical Science on Enrolments in Chemistry and Physics

The Education Department has been open and definite in its view that the traditional dominance of the 'big four' group of subjects is unjustifiable and unnecessarily constraining upon students in view of the relatively small proportions of students who ultimately opt for tertiary studies in either the pure sciences or mathematics. There is no doubt that these subjects are perceived by the great majority of students and teachers as being difficult and suitable only for the most able students.

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[1] See Appendix II for details of statements from these Institutions in relation to Physical Science.

Some teachers perceive these courses of study as having developed into an "elite" group within the curriculum, making heavy intellectual demands of students and carrying a corresponding status for those who venture and are successful in them. Concern has been expressed not just with the proportion of the student population studying the various subjects offered in schools, but also with the abilities of students comprising each subject group. In this context, the ability test (ASAT) used to scale the marks obtained by students for each TAE subject provides public evidence on which subjects can be compared. It has been claimed by many of those interviewed in this study that the 'big four' subjects have become valued increasingly as a measure of the students' general intellectual ability rather than simply as evidence of preparation in the particular academic disciplines. According to this viewpoint many students enter these courses, not for their content or suitability, but primarily to improve their opportunities and to "keep their options open" in relation to tertiary courses.

Physical Science breaks the bind of the 'big 4', eases the tension on kids with regard to subject choice which will give them a balanced education and provide a good link with Biology and Maths 1.
- School Principal

The appropriateness of the current TAE Physics and Chemistry courses even for the tertiary-bound student is questionable. They are designed to serve the needs of the elite specialist group who eventually do post-graduate work, rather than the needs of students who terminate physical science studies at different levels. The needs of the strong post-graduate tail are wagging the dog.
- Education Department Officer

The introduction of Physical Science as a TAE subject was expected by its advocates to offset much of this tendency by offering students the possibility of doing both chemistry and physics in one subject. Moreover, because of its reduced mathematical requirements, students taking Physical Science would be able to take Mathematics I instead of both Mathematics II and Mathematics III. The combined effect of this would be to

allow students the option of taking two subjects to cover these areas rather than having to commit themselves to the more usual package of four subjects, thereby broadening the range of other subjects open to them.

There is a danger of Physics and Chemistry being shouldered out by Physical Science, especially in isolated places.
- Tertiary Science Academic

The Education Department people don't like difficult subjects. It may be their aim to get Physics and Chemistry students to take Phyiscal Science instead.
- Tertiary Science Academic.

The forces in our society may well mean that once Physical Science is introduced to schools in Western Australia Physics and Chemistry may be squeezed out. It happened in New South Wales.
- Tertiary Science Academic

Physical Science is unlikely to erode intakes in pure Chemistry and Physics; it is more likely to draw from students ordinarily taking Biology but who want to do some Chemistry and Physics.
- Tertiary Science Academic

I do not feel that the school subjects of Physics and Chemistry will be adversely affected unless they continue to be presented in the current dry fashion. Besides that is not a good reason to oppose the addition of Physical Science.
- Tertiary Science Academic

Such a change was perceived by some opponents of the innovation as a threat to the traditional disciplines of chemistry and physics. No-one could have been sure at that time what effect Physical Science would have on enrolments in these subjects, and there was some evidence from other states and countries which indicated a general decline in popularity of studies in chemistry and physics. It was not surprising, therefore, that the tertiary representatives from these disciplines were initially opposed to the introduction of Physical Science. There were, of course, other grounds argued for opposing the proposed subject, but the concern of some tertiary chemists and physicists about a possible erosion of enrolments in their traditional disciplines has been a potent

factor influencing their early attitudes to Physical Science. Indeed, the fear was expressed by a few that Chemistry and Physics might ultimately be phased out of secondary school programmes altogether, particularly in smaller schools, if and when Physical Science were firmly established[1]. However, the majority evidently accepted the case for such a course, and expressed confidence that TAE Chemistry and Physics would continue to attract substantial members of able students.

Nobody in the Education Department ever intended that Physics and Chemistry should be phased out....We did recognize that there could be a problem with small, non-viable classes in some schools and hoped to devise a combined Physics and Chemistry and Physical Science course which could be taught in the same classroom.

- Education Department Officer

2.5.3 Status of Physical Science

Since one of the main objectives behind the new course was to provide those tertiary aspirants interested in a TAE level background in physical science with an alternative to Chemistry or Physics, it was essential that Physical Science be accepted on the same terms when TAE aggregates were being determined. As already noted, it was intended that Physical Science should be comparable to Chemistry and Physics in terms of conceptual difficulty and intellectual challenge, that the emphasis on mathematical calculations would be lessened, and

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[1] Being aware from our early discussions that the effects of Physical Science enrolments upon numbers in other subjects was an important issue, we have monitored enrolments in all the science subjects in Year 11 for 1978 and 1979 in those schools where Physical Science has been offered. These figures are discussed fully in two earlier reports from the project and a summary of the findings is presented in the Chapter 4 of this report.

that the essential elements of chemistry and physics would be preserved within a single subject. Clearly, the design of a course to meet these conditions would be no easy task; and it is not surprising that negotiations within the S.S.E.C.C. about the aims and content of Physical Science were prolonged.

Many tertiary chemists and physicists were reluctant, at least initially, to concede that topics they had traditionally considered important should be omitted or reduced in scope in the new course. Indeed, this had been one of the key reasons for the lack of progress in the initial discussions about the establishment of the subject. However, by the time the S.S.E.C.C. was formed, there was greater support within the tertiary institutions for such a subject. The committee was attracted by the emphasis on technological applications and societal implications underlying much of the philosophy of the Victorian course. Yet there was considerable concern about some of the chemistry and physics content of that course and a good deal of the discussions in the S.S.E.C.C. centered on this aspect. In fact, a number of compromises eventually had to be accepted in the final draft of the course syllabus in order to satisfy some of these concerns. In the end, the syllabus included significantly more chemistry than physics - a fact which perturbed some academics in the latter discipline. Moreover, the negotiations appear to have resulted in the inclusion of some topics which have not fitted comfortably within the total sequence as it later developed in the written guides and resource books.

The main priority was to get the tertiary institutions to accept the course as a full TAE subject. I was prepared to include some topics in the course on these grounds. I would have preferred it if the content had been less than that which was included. But I felt that that could be modified in time.

- One committee member's view

The outcome of the negotiations within the S.S.E.C.C. formed the basis of the course outline finally produced for submission to the TAEC and BSE. This outline departed substantially from the Victorian course in terms of content and overall structure.

2.6 CONCLUSION

The process of negotiating agreement among the various interest groups on the S.S.E.C.C. was a delicate one, which often led to compromises by one or other of the parties involved. Despite general acceptance of the broad principles and content of the approved outline, many of the issues discussed in this chapter continued to permeate later developments and surfaced at various times in discussions about the course and its implementation. The next chapter examines a number of issues associated with the production of the written materials for the course and their dissemination to schools.

CHAPTER 3: THE PRODUCTION AND DISSEMINATION OF THE MATERIALS

3.1 PREPARATION OF COURSE MATERIALS

Following the S.S.E.C.C. agreement on the structure, content and objectives of Physical Science, the Education Department, recognising that no available text would be sufficiently comprehensive to meet the demands of the syllabus, decided to produce supporting materials for the adopting schools. The Department's Curriculum Branch was given the task of preparing these in time for the pilot introduction of the course in 1978. It was intended that the first editions would be in trial format such that they could be readily modified in the light of experience gained in the schools. A major guideline at this stage was that the materials and student activities should be capable of introduction with apparatus and equipment already available in most of the schools. It was not intended that there should be a need for any major allocation of resources to purchase new laboratory equipment or other aids.

Production of the materials began officially with the convening of a number of science teachers and the Department's central staff for a two week workshop in November 1976. During the workshop, groups of teachers worked on the various proposed units, drawing on a wide range of published texts and other resources to establish a framework and outline of content for the student resource books and teachers' guides.

Co-ordination of the writing phase, the associated consultative processes, and all final editing was the responsibility of two selected education officers from the secondary science section of the Curriculum Branch. For convenience these will be referred to as the 'course developers' in the following discussion. These officers also played a major role in disseminating the materials to schools and in organising in-service courses for the first group of Physical Science teachers.

3.2 DISSEMINATION TO SCHOOLS

While the materials were being written, preparations began for introducing the course into the schools in 1978[1]. The Education Department's major priority at this stage was to disseminate the course among Government schools, but the decision was taken to make the course materials freely available also to interested non-Government schools. Information about the course was disseminated both in writing and through visits to schools, tertiary institutions and professional bodies. Invitations to meet and discuss the new course with the Department's superintendents and course developers were sent to all school principals in 1977. These early meetings were an important influence promoting adoption of the course by the initial group of trial schools.

With support from Schools Commission funds, the Education Department organised a series of in-service meetings towards the end of 1977 for teachers from the first adopting schools. These meetings continued at regular intervals until December 1979. The Education Department clearly made a considerable investment in terms of energy and resources in the development and dissemination of the new course. Superintendents of science and other senior Department officers provided a continuing and high level of support and interest throughout this period.

3.3 ISSUES RELATING TO THE PRODUCTION OF WRITTEN MATERIALS

Though the two course developers wrote substantial parts of the draft materials themselves, other units, or parts of units, were developed by experienced science teachers employed on a contract-writer basis. Drafts were then sent to appropriate consultants who had agreed to review the materials on a voluntary basis. In general, each unit

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[1] Although the course consists essentially of the TAE syllabus content it became synonymous with the written guides and resource-books being prepared by the Education Department. This was true for both Government and non-Government schools (although one of the latter did commence the course without being aware of the existence of the materials).

was seen by two or three science content consultants, three educational consultants and two or three teachers. Feedback from the consultants was used in preparing the final drafts of the materials to go to the adopting schools.

3.3.1 Role of Contract-writers

Given the short time available for compiling the resource books and teachers' guides, writers were asked not to devise completely new materials, but rather to build on the outline framework for the units developed at the initial workshop in 1976. The frameworks had been derived from a number of different texts and available resource materials; writers were expected to extract suitable activities from these sources, and to incorporate supplementary materials to provide a coherent development within each resource book. Copyright clearance was obtained for this purpose. However it was not always possible to locate material that was suitably close to the needs and purposes of the course and writers therefore had to adapt the available material quite considerably. Moreover, the task of deciding what should be included as supplementary reading material was a difficult one. In the event, rather more textual content was incorporated than had been originally planned and this increased the difficulty both of writing and editing and of attaining a reasonable comparability of structure and presentation across the different units being prepared.

3.2.2 Role of Consultants

Many of the consultants contributed substantially by suggesting changes to the guides and resource books. This was a time-consuming and demanding task and some consultants were unable to respond by the suggested deadlines. This caused delays in the whole process of feedback. A second difficulty faced by the course developers arose from the sometimes diverging views of consultants about the draft materials. While every attention was given to the feedback it proved impossible to take into account all the suggestions made. However, many

changes were made and errors in content and typography were corrected. Inevitably, not all defects or errors were spotted and some changes made for the final draft actually led to new errors or inconsistencies.

Under constraints of time and fixed production deadlines it was not possible to go through the review and revision process more than once for each draft unit, and consultants did not have the opportunity to see the re-drafted materials before they were printed in trial form. Some considered this to be inappropriate or unacceptable; indeed, one subject consultant was sufficiently perturbed to withdraw from the review panel altogether on the grounds that he believed the course materials produced in this way were inadequately developed to warrant their circulation to schools. The Education Department responded by convening representative groups from among the consultants who assisted the course developers in the further revision of the materials for the second trial edition to be used in 1979.

3.3.3 Development of the Written Materials

Those involved in the development and review processes were not unanimous in their views about the validity and the effectiveness of the development model used. One aspect, which was raised by some of those interviewed, had to do with editorial control over the choice of content to be included. Some content consultants (though not the majority) felt strongly that the initial writing of the student materials should have been done by tertiary specialists in the relevant disciplines. Most of the teachers and those closely associated with the schools, however, favoured the consultative review model in the belief that experienced teachers and curriculum writers with a background in the sciences were in the best position to choose and sequence the content and to select activities that would have the best value from an instructional point of view. Underlying these arguments was a more basic issue, that of who should control the school curriculum at this level.

Traditionally the tertiary institutions have had the major say in what was to be included in science courses leading to the Tertiary Admissions Examination. On this occasion the course developers (and therefore in effect the teachers), by undertaking the detailed course development, effectively controlled the content of the guides and resource books through which the syllabus was mediated. Though the syllabus itself had been agreed to in discussions with tertiary specialists, there was considerable opportunity during the development of the course for interpretation of content details and teaching approaches. The consultancy arrangements of the model did permit the tertiary specialists to participate through their criticism of the draft resource books, but responsibility for the initial structuring and the final decisions about content resided with the Education Department's course developers.

In any discussion of the development model it is important to bear in mind time and other constraints under which the writing took place. The course developers ideally would have liked to have had more time for re-drafting the materials but that was not possible on the schedule that had been set for them. They were hampered to some extent by the fact that, since consultants were contributing their time gratis, it was not easy to insist upon tight deadlines and there were thus considerable differences in turn-around time from one consultant to another. In retrospect, the course developers felt it might have been preferable to have used fewer consultants, employed on a contractual basis -- although this inevitably would have added significantly to the cost of production.

Despite the acknowledged problems and difficulties, the general feeling among the course developers, contract writers and most of those involved in the consultative process was that the basic model had been valid and effective. The course developers found the contributions from consultants particularly valuable, and most of the consultants and contract writers felt that they had been able to make a worthwhile

contribution to the quality of the materials through the review and commentary process.

3.4 DISSEMINATION OF INFORMATION TO SCHOOLS

Throughout the early negotiations to have the course accepted as a TAE subject and during the subsequent development of the guides and resource books a considerable number of experienced teachers of Chemistry and Physics had become involved in various aspects of the innovation. Science staffs in Government schools were thus aware to some extent of the development of the new course and of its rationale and overall structure. The Department also had well-developed communication networks -- both formal and informal -- within the school system which were utilised by the course developers and superintendents to ensure that maximum information was made available to principals and teachers. These networks permitted those in the schools to discuss informally among themselves and with Department personnel the various questions and difficulties they were likely to face if they decided to adopt the course. Consequently, the number of Government schools that indicated a desire to adopt the new course in its first year was considerable. Not all of these did so, however; those schools in which there were likely to be small numbers, or in which Chemistry and Physics class sizes might be jeopardised, were discouraged by the Education Department from adopting Physical Science at the initial stage. Nevertheless, it is accurate to say that interest in the new course was widespread and positive in most of the Government schools.

In non-Government schools the same networks did not exist. Admittedly, they did receive formal letters of advice about the new course and the Education Department personnel responded to any request for further information by visiting schools and talking to staff and school principals. Moreover, the non-Government schools were offered full access to the trial versions of the guides and resource books and were invited to participate in the in-service meetings planned for the first two years of the course. Indeed there was a strong motivation amongst advocates of the innovation for encouraging some of the major independent schools to adopt the course in the early trial stages, since this could strengthen the position of Physical Science as a full TAE

subject, as planned. In the event, only one independent school adopted the course in the first year while three more did so in the following year. A survey of schools, both Government and non-Government, which did not adopt the course in 1978 was carried out as part of the evaluation study. This revealed that all schools felt that they had received adequate communication about the new course from the TAEC and BSE as well as the Education Department. In the case of non-Government schools, the lack of informal communication networks similar to those within the Government school system may have played some part in the disproportionately low adoption rate in these schools. However, information received in the survey made it clear that other considerations ultimately determined the decisions in the schools. The various reasons given by non-adopting schools for delaying the introduction of Physical Science are discussed in Section 3.6.

3.5 COMMUNICATION WITHIN SCHOOLS

The communication of information within schools was an important element of the pre-adoption phase. Where the communication between principals and senior science masters was effective, and where there was agreement that the course was a useful addition to the upper-school curriculum, the adoption decision was relatively straightforward. This was the most common situation among the first group of adopting schools. There were a few instances, however, where communication between principals and teachers was not so effective; in a small number of these schools there were serious misconceptions within the administration as to the nature and purposes of the course. Where this was the case, numbers of students who did not have the requisite ability or science background were encouraged to attempt the course.

The nature of the advice received by prospective Physical Science students varied from school to school. In most schools, notification of the course was typically given in two ways: officially, the students were informed of the availability and general character of the course by the school guidance officer; informally they received much of their detailed advice from the teachers likely to be involved in teaching the course. Not unexpectedly therefore, the students' initial perceptions about the course were largely determined by these teachers,

most of whom were enthusiastic about the planned adoption. However, the teachers generally accepted that the advising of students was a delicate matter and one which they had to approach carefully. Initially, they had only limited information on the details of content for the course (since the materials were at that stage still being produced) and they were aware that the tertiary institutions had already indicated that the subject was not appropriate for anyone wishing to pursue most of the science and science-related courses at tertiary level. Hence, publicity about the course was generally handled cautiously, and care was taken not to mislead students about implications for further tertiary science study, particularly for those students with good science background who were unsure about their future careers. Students who wished to keep their options open in regard to further studies in science or science-related areas and who were considered capable of successful studies in Chemistry or Physics at TAE level were generally advised by teachers and guidance-officers to take the latter subjects rather than Physical Science. It is perhaps worth noting that, despite these constraints on student choices, Physical Science classes in the adopting schools contained a reasonable proportion of students who had achieved Advanced grades in Achievement Certificate Science and Mathematics. In the majority of adopting schools, students entering Year 11 with an Achievement Certificate Science background at the level of Intermediate Pass or below were counselled away from the subject. However, in some schools a number in this category did enrol in the course. As will be seen from the data in Chapter 4, almost all of these students subsequently dropped out of the course during their first year of study.

3.6 FACTORS INFLUENCING DECISIONS ON ADOPTION

Decisions about adoption or non-adoption of the Physical Science course were taken at school level. In this process the perceptions and attitudes of the principal and senior science staff were of considerable importance.

3.6.1 Attitudes to the Course

In all the schools where the course was first adopted there was considerable support for its introduction from senior

masters in science, the principal or both. Principals were mainly attracted by the opportunities provided by the course in relation to broadening the range of subjects which students might choose. They also felt that Chemistry and Physics were too difficult for many students in the school. This favourable attitude to the new subject was shared by the majority of principals in other schools where it had been decided not to adopt the course at this stage. Senior masters and teachers of Physical Science were impressed by the emphasis on practical, relevant activities promised by the early information on the course. They also liked the ideas underlying the technological and cultural themes of the course.

Among the non-adopting schools there was a small number where the school science staff or principals were either unenthusiastic or antipathetic to the whole notion of such a course on philosophical, educational or practical grounds. Some teachers of Chemistry or Physics were unhappy about attempts to marry the two disciplines in such a course and felt that many essential aspects of these disciplines would be excluded or 'watered-down' in the process leading to what some called a 'mickey-mouse' course. Some principals felt that there were already too many science subjects at this level and would have preferred a non-TAE subject to be introduced instead. Parental attitudes appeared to be a factor which affected perceptions and decisions more directly in non-Government schools than in Government schools. Because the independent school principals felt that they were closely accountable to their parent groups they were inclined to be more cautious about introducing the course while it was at the trial stage. As one might expect, most of these principals and their science staff were content to await the results of the trials in the new subject and to monitor the effects on enrolments in other subjects within the trial schools. The other major factors which deterred schools from immediate adoption of the course were resource implications (including staffing) and the existing status of Physical Science as a preparation for major tertiary-based careers. These are discussed in the following sub-sections.

3.6.2 Staff and Resource Requirements

All prospective Government schools were informed that no extra staff or laboratory space would be available to support the introduction of Physical Science. It was expected that adopting schools would make internal adjustments of classes and staff to accommodate any Physical Science classes they might form. Moreover, the course materials were designed to make use of resources and laboratory equipment already available in most Government High Schools, although some units did incorporate activities for which some extra equipment had to be made available to the trial schools. In the larger Government schools these constraints appear not to have caused any major difficulties, but the smaller Government schools were inhibited significantly by staffing and resource implications. This was particularly so where upper-school enrolments in Chemistry or Physics were small and there appeared to be a possibility that these classes might be further reduced in size by the introduction of Physical Science.

The independent schools cited staffing and resource implications as a major factor inhibiting them from early adoption of the new course. While many of them could have offered the course it was not perceived as sufficiently urgent or important to do so at this early stage, since it would inevitably draw resources away from other upper-school subjects.

On the positive side, the fact that the new course was designed so as to maximise the use of apparatus and resources already present in most schools was perceived as facilitating the adoption of the course. Moreover, the availablity to schools of resource books and teachers' guides without charge was an attractive feature, which was particularly appreciated by non-Government schools.

3.6.3 Status of Physical Science

From its inception, Physical Science was accepted by all the tertiary institutions in the State as a full alternative subject to Chemistry or Physics for matriculation purposes. This was a vital factor in the adoption decision within each school. However, it was clear from the beginning that many science or science-related courses at some institutions could not easily be followed by students who chose Physical Science instead of Chemistry or Physics. In this respect the status of the latter subjects was perceived by many principals, teachers and students as being different from the new subject. Many of the schools who did not adopt the course indicated that their interpretation of the statements of advice about Physical Science issued by the institutions was an important factor in their decisions. Comments from principals and guidance officers indicated that they felt it important to maintain an emphasis on the traditional set of TAE science and mathematics subjects in order to ensure that their students preserved the maximum range of tertiary course options. Many of these schools indicated that if Physical Science had been accepted by the institutions as sufficient for entry to more of their science-related courses, they would probably have offered the subject.

Associated with this was the feeling expressed by many teachers that the new course would require four or five years in which to establish itself. Its real status, relative to other science subjects, would be determined by the success or otherwise of students of the course in various tertiary courses subsequently studied. This viewpoint was shared by many tertiary academics who had an open mind about the potential of the new subject.

3.7 CONCLUDING COMMENTS

Most of the issues dealt with in this chapter arose in respect of aspects of the development and dissemination of the course and its

materials prior to its implementation in schools. Once schools had begun this task the main focus of interest and activity switched to the students and teachers in these trial schools. The principal means of dissemination of information to the teachers at this stage was the in-service programme which commenced in the latter part of 1977. However, dissemination activities directed towards potential adoptors of the course in subsequent years continued in a fairly steady fashion throughout 1978. Seminars, departmental circulars and newsletters were the major means of communication with schools and others known to be interested in the course. Interested schools were again offered cost-free materials and a further round of in-service meetings in 1978-79. By the second year an additional sixteen schools decided to adopt the course while all the initial adopters continued to support the innovation by enrolments of Year 11 students for this second year. As mentioned previously, development of the course materials continued with the modification of the resource books and guides on the basis of feedback from teachers and consultants. However, such changes were kept to a minimal level at this stage since the development plan envisaged that major changes should await the evaluation of the first two years of course implementation. Reactions of tertiary personnel to the course and the content of the written materials are examined further in Chapter 6 of the report.

CHAPTER 4: THE PHYSICAL SCIENCE STUDENTS: ACADEMIC BACKGROUNDS AND INITIAL PERCEPTIONS

4.1 INTRODUCTION

In 1978 as part of the evaluation study, data relating to the backgrounds and perceptions of the first cohort of Physical Science students were obtained from a survey involving

(a) a questionnaire administered to all the Physical Science students within the first two weeks of the commencement of their Year 11 studies, and

(b) an enrolment analysis form completed by the majority of Year 11 teachers involved with these classes.

The findings from this survey were described and discussed in the evaluation project's first formal report[1].

In 1979 a similar survey using the same procedures was carried out with the second cohort of Year 11 Physical Science students. The present chapter focuses initially on the data from this second survey; comparisons with the 1978 data are made where shifts or persisting features are of interest[2]. It also looks at certain changes which have taken place within the first cohort as the students proceeded through their two years of study in the subject. To identify these changes, a brief questionnaire was administered to all metropolitan Year 12 Physical

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1 "Physical Science Evaluation 1978". Co-operative Research Series No.3, Education Department of W.A., 1979.

2 Some of the data on which the discussion in this chapter is based were first made available on a limited distribution basis in an interim report: "Characteristics of 1979, Year 11 Physical Science Student Population. Education Department of W.A., 1979.

Science students in the closing weeks of 1979 and their responses were compared with those made to the same questions two years earlier. Data relating to the academic backgrounds of the group of students withdrawing from the course were also compared to those of the group of students who completed the course.

4.2 SCHOOL AND STUDENT SUB-GROUPS

Physical Science was offered at the Year 11 level in 1979 by a total of 35 schools. For the sake of the discussion which follows, these schools will be classified as:

Group A Schools -- those 19 schools which made up the initial group of trial schools and which piloted the introduction of Physical Science at the Year 11 level in 1978. These schools included both Year 11 and Year 12 students in 1979.

Group B Schools -- those 16 schools in which the subject was offered to Year 11 students for the first time in 1979[1].

For some of the discussion, students will be distinguished according to year of entry (1978 or 1979); at other times comparisons will be between students in the two groups of schools. The scheme of labels and subgroup identifiers shown in Figure 4.1 will be used to name the groups being compared or described in particular instances.

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[1] These groups were referred to as 'original' and 'incoming' schools respectively in the project's interim report "Characteristics of 1979 Year 11 Physical Science Student Population" prepared for the Education Department in July, 1979.

1978	1979	1980
Cohort 1 (11) (Year 11)	Cohort 1 (12) (Year 12)	
	Cohort 2A 2B (Year 11)	Cohort 2A 2B (Year 12)

Figure 4.1: Labels and identifiers used to distinguish particular groups of Physical Science students

Because there was a substantial change in the student numbers in Cohort 1 from 1978 to 1979 (due mainly to withdrawals) the expanded labels, Cohort 1(11) and Cohort 1(12) are used where the two groups need to be distinguished or where some reminder of the differences is warranted.

The second group of students, those who commenced as Year 11 students in 1979, is denoted Cohort 2. Where it is necessary to distinguish between the students of Cohort 2 in terms of the group of schools to which they belong, the distinguishing labels, Cohort 2A and Cohort 2B, are used.

4.3 SEX COMPOSITION OF PHYSICAL SCIENCE CLASSES

Along with the somewhat broader appeal anticipated for Physical Science relative to Physics and Chemistry, it might have been expected that the subject would fare better in terms of its attractiveness to girls. While boys continued to outnumber girls (approximately 3-to-1) in Physics and Chemistry, the ratio of boys to girls in Physical Science has been less unbalanced. As can be seen from Table 4.1, girls made up 36% and 39% of the total Year 11 enrolments in Physical Science in 1978 and 1979 respectively.

TABLE 4.1 SEX COMPOSITION OF PHYSICAL SCIENCE INTAKES FOR 1978 AND 1979

Year of Intake	Participating Schools	Percent of Total Year 11 Enrolment		Ratio of GIRLS to BOYS
		GIRLS	BOYS	
1978	Group A schools	36	64	1 : 1.8
1979	Group A schools	35	65	1 : 1.9
	Group B schools	43	57	1 : 1.1
	All schools	39	61	1 : 1.6

4.4 ENROLMENT PATTERNS IN PHYSICAL SCIENCE

Though the total Year 11 enrolments in Physical Science in 1978 and 1979 were 369 and 688 respectively, it is perhaps of more interest to consider these figures in terms of the proportions they represent of the total Year 11 intakes in the two years. Table 4.2 summarises enrolment data obtained from eighteen schools in 1978 and twenty-eight schools in 1979. For these samples the participation rates in Physical Science (as a proportion of the total Year 11 population) were approximately 11% in both 1978 and 1979. Corresponding participation rates for Chemistry, Physics, Biology and Human Biology are also shown. From these figures it would appear that there was no obvious impact on participation rates for Chemistry or Physics as a result of the introduction of Physical Science in the first year (1978). In 1979, however, there was a marked reduction in participation rates in both Physics and Chemistry in the Group B schools. Participation rates in Biology and Human Biology showed slight declines in both years. While it is possible that Physical Science has had some impact on enrolments in these latter two subjects it should be noted that a substantial number (approximately 60%) of Physical Science students were also enrolled in Biology or Human Biology.

TABLE 4.2 ESTIMATED PARTICIPATION RATES[1] (PERCENT OF TOTAL YEAR 11 INTAKE) FOR YEAR 11 SCIENCE SUBJECTS IN 1977, 1978 and 1979

	Group A Schools			Group B Schools	
	1977	1978	1979	1978	1979
Physical Science	N/A	11	12	N/A	11
Chemistry	25	24	24	28	22
Physics	23	21	22	25	20
Biology	52	49	45	41	40
Human Biology	36	35	33	30	28

[1] Participation rates shown are those for the 18 schools in 1978 and 28 schools in 1979 for which completed enrolment analysis forms were available.

4.5 FUTURE STUDY PLANS OF PHYSICAL SCIENCE STUDENTS

As shown in Table 4.3, over half of the students entering Year 11 in 1978 and 1979 reported that they expected to continue to some form of post-secondary education or training. Less than 10% in each year anticipated leaving school before completing Year 12. (The actual attrition within Cohort 1 over the two years of the course was 28%, approximately three times the rate predicted from the students' expectations reported at the time of first taking up the course.)

TABLE 4.3 PROPOSED FURTHER-STUDY PLANS REPORTED BY STUDENTS ON ENTERING PHYSICAL SCIENCE IN 1978 AND 1979 (ALL SCHOOLS)[1]

Reported Study Plans		1978 Intake	1979 Intake
To continue to some form of tertiary or post-secondary study		54	60
No further study proposed	To complete Years 11 and 12	37	31
	To complete Year 11 only	7	9
No plans at this stage (uncertain)		2	-

[1] Table entries are percentages (%) of students who indicated each response.

Some general indication of the fields of post-secondary education or training to which the Year 11 students hoped to proceed can be obtained from Table 4.4. Entries in this table are percentages of the total Year 11 Physical Science numbers. Though not shown in the table, most tertiary-bound students in Cohort 1 had nominated courses for which Physical Science was approved by local institutions, whereas a significant number (7.5%) of Cohort 2 expressed aspirations towards courses in engineering, dentistry or medicine, despite official advice from the relevant institutions that Physics and Chemistry were considered necessary for these courses.

TABLE 4.4 EXPECTED POST-SECONDARY OR TERTIARY STUDY FIELDS REPORTED BY STUDENTS ENTERING PHYSICAL SCIENCE IN 1978 AND 1979 (ALL SCHOOLS)[1]

Further Study Fields	1978 Intake	1979 Intake
Teaching	23	12
Engineering, Physical Sciences, Computing, Architecture, Drafting	6	5
Biological sciences, Forestry, Veterinary science	9	8
Medicine, Pharmacy, Therapies, Nursing, Social Work, Psychology	12	12
Business, Finance, Commerce, Economics, Law	4	5
Humanities, Arts, Library Studies, Art	4	3
Clerical, secretarial		0.5
Apprenticeships		6
No post secondary studies	37	31
Undecided	3	5

[1] The groupings of subjects in the table have been chosen to facilitate the joint tabulation of the 1978 and 1979 responses for which some ambiguities inherent in the data necessitated different coding schemes.

4.6 PRIOR ACHIEVEMENT PROFILES AND STUDENTS' INITIAL EXPECTATIONS OF SUCCESS

Virtually none of the entering students in 1978 or 1979 expected to have difficulty achieving reasonable success in Physical Science. As shown in Table 4.5, over four-fifths of the students in each cohort expected to do well or very well in the subject, while the remainder felt they would at least "just pass".

TABLE 4.5 YEAR 11 PHYSICAL SCIENCE STUDENTS' ESTIMATIONS OF HOW WELL THEY EXPECTED TO COPE WITH THE SUBJECT (ALL SCHOOLS)[1]

	Expectation			
	Fail	Just Pass	Well	Very Well
1978	-	16	74	10
1979	1	15	74	10

[1] Table entries are relative percentages

Many of the teachers who had worked with Cohort 1 in 1978, however, were more conservative in their estimations. Most felt that students who had not attained the Ordinary Credit level in Year 10 Mathematics and the Intermediate Credit level in Year 10 Science would find it increasingly difficult to cope with the conceptual and quantitative demands of the subject. These intuitive thresholds are indicated by the symbol (x) on the base lines of Figures 4.2 and 4.3. In each year, more than 25% of the entering students had Year 10 Mathematics achievement scores below threshold. However, only about 10% in each year entered with Year 10 Science achievements below the threshold for that subject.

On the whole, the Year 10 achievement profiles for Cohorts 1 and 2 seem consistent with the patterns anticipated by the course developers. As would be expected, the profiles for Physical Science students revealed a somewhat larger spread and generally lower median achievement levels than was the case for the groups taking Physics and Chemistry. Apart from the relatively higher proportion of Cohort 2

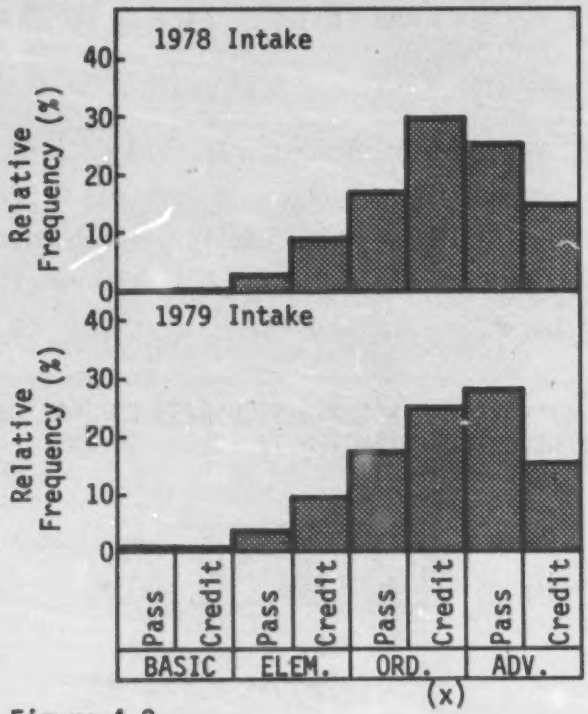

Figure 4.2

Year 10 Mathematics grade distributions for total Physical Science intakes in 1978 and 1979.

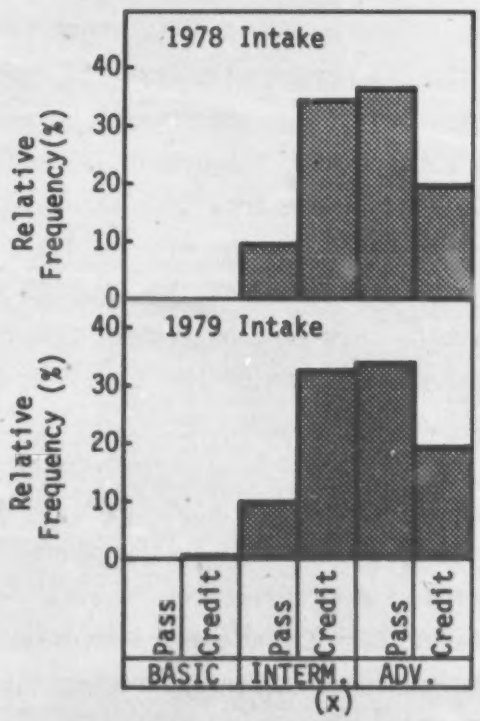

Figure 4.3

Year 10 Science grade distributions for total Physical Science intakes in 1978 and 1979.

students who had achieved at the Ordinary Credit level in Year 10 Mathematics, the entering profiles for both cohorts are essentially similar. Though the corresponding data are not shown here, the population of Physical Science students resembled most closely that for Biology, although the Physical Science student was more likely to have achieved an Advanced level Science grade at Year 10 than was the Biology student. Human Biology, in contrast, drew more heavily than did either of these subjects from the Intermediate Science and Elementary Mathematics levels. Physics and Chemistry continued in 1979 to attract a high proportion of the more able Science and Mathematics students; over 50% of the entering groups attained Advanced Credit grades in Year 10 Mathematics or Science.

It should be noted that achievement profiles for individual schools showed quite marked variation across the schools for which these data were available. In 10 of the 28 schools in Cohort 2, for example, the Year 11 Physical Science classes in 1979 included no student with Year 10 Science achievement below the Intermediate Credit level, whereas the proportion of intake with achievement below this level was as high as 20% in other schools.

4.7 PERCEIVED DIFFICULTY OF PHYSICAL SCIENCE

Table 4.6 summarises the responses made by the 1978 and 1979 entering groups, Cohort 1 and Cohort 2, to an item on the Year 11 questionnaire which asked students to rate each of the indicated subjects according to their difficulty relative to Physical Science. An index of difficulty for each subject (relative to Physical Science taken as 1.00) was derived from these percentages according to the procedure described in Appendix III. For both cohorts, Physical Science is seen to be close in difficulty to Mathematics I and Biology, but substantially less difficult than Mathematics II and III and (to a lesser extent) Physics and Chemistry.

4.6 PERCEIVED DIFFICULTIES OF TAE MATHEMATICS AND SCIENCE SUBJECTS RELATIVE TO PHYSICAL SCIENCE (AS REPORTED BY YEAR 11 PHYSICAL SCIENCE STUDENTS ONLY; ALL SCHOOLS)[1]

Subject	Intake	Difficulty relative to Physical Science: Much Easier	Easier	About the same	Harder	Much Harder	Index 1978	Index 1979
Maths II, III	78		1	4	35	59	1.5	
	79	1	2	4	30	62		1.5
Physics	78		1	9	52	37	1.4	
	79	1	1	10	50	37		1.4
Chemistry	78		1	14	52	32	1.4	
	79	1	1	15	50	32		1.4
Maths I	78	1	15	59	21	3	1.0	
	79	2	12	61	23	2		1.0
Biology	78	4	33	48	14	1	0.9	
	79	5	30	46	14	3		0.9
H. Biology	78	14	37	37	10	6	0.8	
	79	14	33	36	11	3		0.8
Maths IV	78	56	36	6	1		0.5	
	79	51	36	7	1	2		0.5

[1] Table entries show percentage distributions of Physical Science students' ratings for the indicated subjects.

4.8 CHANGES OVER TIME

The withdrawal rate (28%) from Year 11 to Year 12 in Cohort 1, and the fact that about 5% of those making up Cohort 1(12) had joined the group since the initial data were gathered, mean that Cohort 1(11) and Cohort 1(12) are not strictly comparable[1]. In the discussion which follows, comparisons that are made refer only to those students in Cohort 1 who started in Physical Science in February 1978 and were preparing to take the TAE as Year 12 students in October 1979. Before looking at the extent to which these students had changed in terms of their interest in science and their expectations of success in Physical Science, it is of interest to examine whether the withdrawing students were representative of the overall entering group or whether they tended to come from the less able sub-section.

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[1] The retention rate from Year 11 to Year 12 for all two-year subjects, in Government schools, was predicted to be 74% for 1979. (Source: Yearbook of Statistics 1979, Education Department of W.A.)

4.8.1 Academic Profile of Withdrawing Students

Figures 4.4 and 4.5 show the distributions respectively of Year 10 Mathematics and Science grades for the initial intake of Year 11 students, Cohort 1(11), and those who had withdrawn by the time of the administration of the Year 12 questionnaire. The data on which the histograms in the two figures are based were derived for statistical returns from the metropolitan Group A schools only. The figures show that the withdrawing group included students from a wide spectrum of prior achievement in Mathematics and Science. The impact of withdrawals was greater for students with weaker backgrounds in these subjects. All those who had entered Physical Science with Basic level grades in either subject had withdrawn by Year 12. Clearly, however, ability to cope with Physical Science was not the only factor which influenced students' decisions to withdraw from the course.

4.8.2 Interest in Science

The histograms in Figure 4.6 allow a comparison to be made between the interest levels reported by the continuing students in Cohort 1(12) towards the end of their course and this same group when they had responded as entering students in the preceeding year. For this particular sub-group, there has been some slight decline in the overall interest pattern[1]. Whereas none of the continuing students had begun the course with highly negative feelings toward science, six students reported 'no interest at all' in science by the end of Year 12.

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[1] Findings in relation to science curricula in general show declines in student attitudes in almost all cases; e.g. see Gardner P.L. "Science Curricula and Attitudes to Science: A Review", The Australian Science Teachers Journal. Vol. 21(2) 1975.

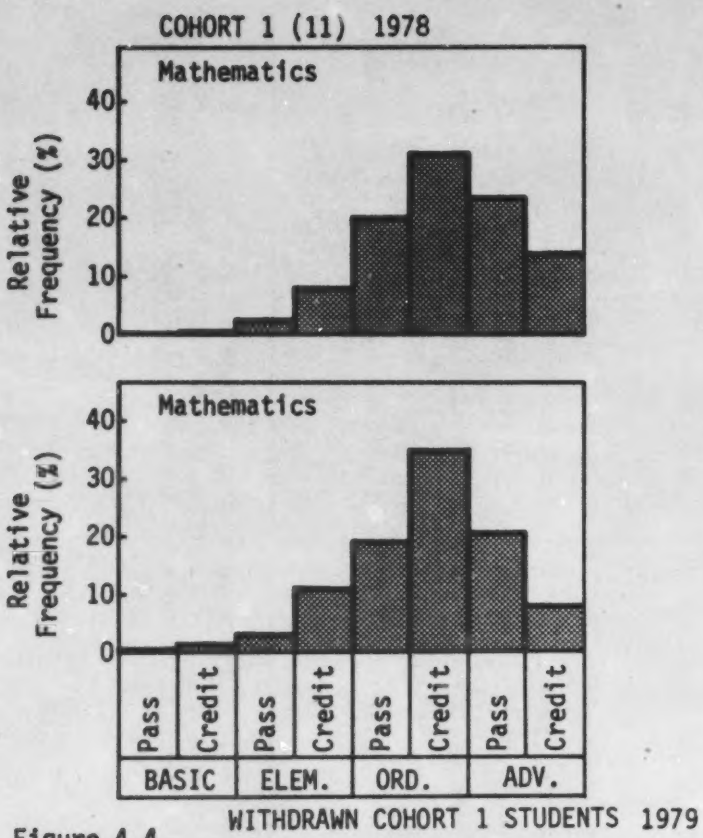

Figure 4.4

Year 10 Mathematics grade distributions for Cohort 1 (11), and for those students of this cohort who withdrew from the course in 1978 and 1979.

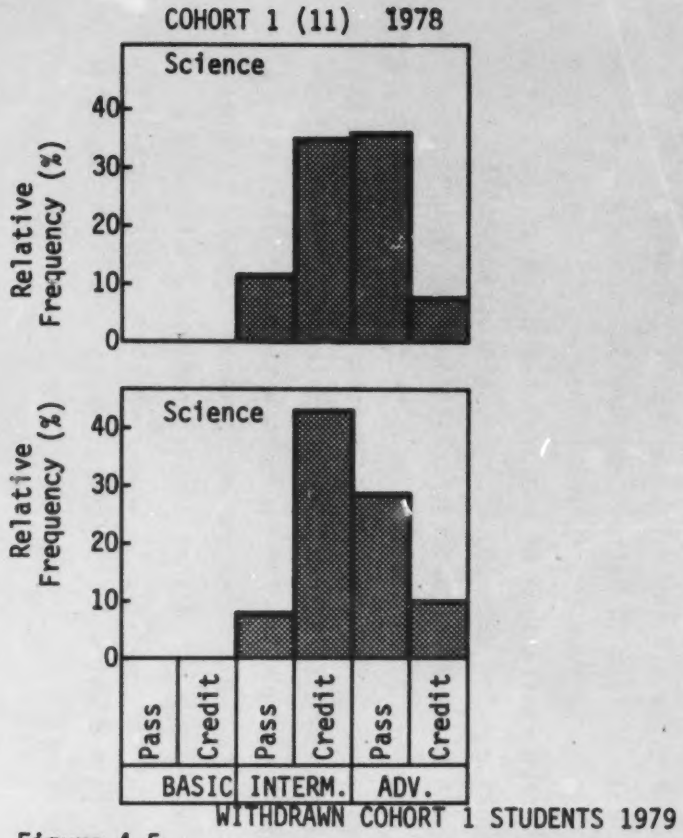

Figure 4.5

Year 10 Science grade distributions for Cohort 1 (11), and for those students of this cohort who withdrew from the course in 1978 and 1979.

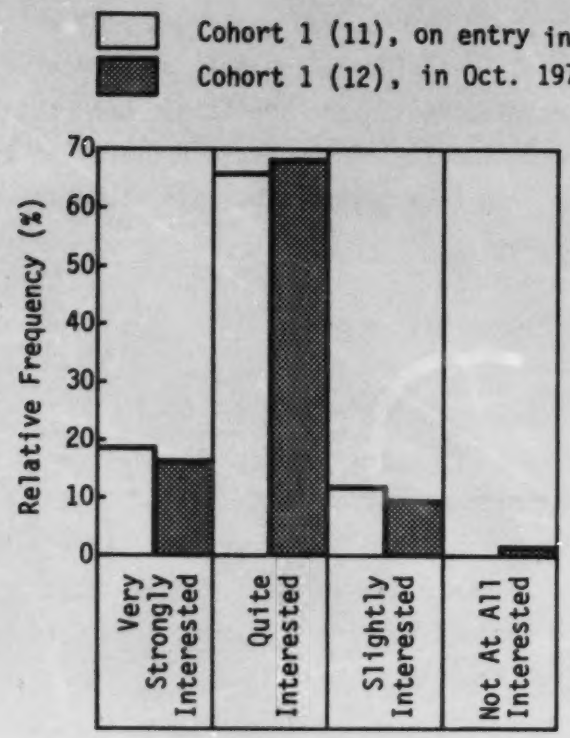

Figure 4.6
Interest expressed in science by students in Cohort 1 (12)

No follow-up data have been obtained for the group of withdrawing students from Cohort 1 and it is not possible to determine whether withdrawal was associated with declining interest in science. Examination of this group in terms of their responses to this item on entering Year 11 revealed, however, that their subsequent withdrawal was unrelated to their initial expressed interest in science.

4.8.3 Expectations of Success in Physical Science

For those Cohort 1 students who continued with Physical Science in Year 12, there was a noticeable decline in confidence regarding their TAE prospects when compared with their expectations on entering Year 11. Whereas only 16% had initially registered some concern about their likely performance in the public examination, this figure had increased to 40% by

the end of Year 12. These changes may well be a particular reflection of a general trend in all subjects as students approach the final examinations. The inevitable uncertainity about the nature and difficulty of the first examination for Physical Science may also have played a part in students' perceptions at this stage.

4.8.4 Perceived Difficulty of Physical Science

Table 4.7 shows how the continuing group of Cohort 1 students in Year 12 rated Physical Science in relation to the other TAE science and mathematics subjects listed. Comparison of these data with those in Table 4.6 shows that, though there are some differences in the scale values for some subjects, the rank ordering of the subject according to perceived difficulty remained the same from Year 11 to Year 12.

4.7 PERCEIVED DIFFICULTY OF TAE MATHEMATICS AND SCIENCE SUBJECTS RELATIVE TO PHYSICAL SCIENCE (AS REPORTED BY COHORT 1 (12)

	Much easier than Physical Science	Easier than Physical Science	About the same as Physical Science	Harder than Physical Science	Much harder than Physical Science	Index of Difficulty Cohort 2 (1979)	Index of Difficulty Cohort 1 (1978)
Maths 2 & 3	1	1	6	36	47	1.6	1.5
Physics	-	1	18	53	20	1.4	1.4
Chemistry	-	-	27	45	19	1.4	1.4
Maths 1	3	20	53	17	3	1.2	1.0
Biology	11	47	36	4	-	0.8	0.9
Human Biology	18	43	24	7	1	0.8	0.8
Maths 4	63	27	4	-	-	0.5	0.5

Note: 1979 Indices adjusted to take account of the fact that percentage figures shown do not add to 100% totals due to missing data in some responses.

4.9 CONCLUSION

The data which have been presented and discussed in this chapter help to provide a picture of the kinds of students who enrolled in Physical Science, in relation to their previous academic backgrounds,general abilities, initial perceptions of the course, and future career plans. They also provide some evidence of variations within the initial cohort as the course progressed from Year 11 to Year 12. The overall pattern which emerges from these data is useful when seeking to interpret the perceptions of teachers and students about the course and the written materials. Issues relating to these aspects are discussed in the following two chapters.

CHAPTER 5: IMPLEMENTATION WITHIN THE SCHOOLS

5.1 INTRODUCTION

For schools taking up Physical Science in 1978 the main support provided for the teachers consisted of in-service meetings held once or twice each term during the two-year introductory phase. The second cohort of teachers, who commenced teaching the course in 1979, took part in a corresponding series of meetings during that year. One meeting was held for the third cohort of Physical Science teachers at the end of 1979. Formal in-service support was discontinued at that time, though teachers were encouraged by the Education Department to organise regional meetings on their own initiative.

Though the in-service programme was clearly the most influential form of support extended to teachers, other formal and informal means of communication played an important part in facilitating feedback and the dissemination of information during 1978 and 1979. These included visits to schools by the course developers and the distribution of a newsletter dealing with various practical issues relevant to implementation of the course.

The teachers in the trial schools were encouraged during 1978 and 1979 to establish informal but geographically related sub-groups for interchange and discussion throughout the year. These geographic groups, as they were called, had varying success. While they seldom met formally, some groups managed to establish useful links for the exchange of reference materials, supplementary worksheets and prepared questions for student evaluation. However, partly because some of the member schools were not geographically close, one or two groups did not function effectively.

5.2 THE IN-SERVICE PROGRAMME

Data gathered in relation to the in-service support provided for the teachers in 1978-79 included field-notes from each of the in-service meetings, informal discussions with participants and more formal interviews arranged towards the end of 1979. Three principal issues emerged in relation to the in-service programmes:

- its value to the implementation process;
- the appropriateness of the model of in-service adopted; and
- the need for ongoing support beyond the initial trial period.

5.2.1 Value to the Implementation Process

The programme represented a major allocation of time and resources, the costs of which were largely met by funding from the Schools Commission. The demands on these resources increased substantially in the second year when two separate in-service programmes were organised for teachers of Year 11 and Year 12 classes. The programme also made demands on schools, with the necessity to release Physical Science teachers for the meetings. Teachers concerned about the rate of progress of their students were very conscious of the cumulative effects of time spent at in-service meetings on the class programme. With such pressures on schools, teachers and students it was clear that the in-service course would be acceptable only if it was perceived as beneficial to the immediate tasks of implementation.

Despite these pressures and demands it was quite clear that all the participants valued the programme of meetings highly. Meetings held prior to commencement of the course in schools provided opportunities for teachers and course developers to share views on a whole range of matters. These included potential organisational difficulties, factors likely to influence student intake, and a variety of concerns over aspects of the course content itself.

Apart from the opportunities they afforded for the sharing of views and experiences, the meetings also allowed teachers to experience many of the more novel experiments included in the course and to receive assistance with unfamiliar content, particularly that dealing with the area of 'science and society'. For teachers involved with Year 11 classes in 1979 there was an added advantage in that they received advice and feedback from some of the teachers who had pioneered the course in 1978. The meetings also provided early feedback to the course developers on positive and negative aspects of the curriculum and permitted teachers to arrive at a consensual approach to difficulties which arose. Importantly, the views teachers expressed at such meetings were conveyed to the Joint Syllabus Committee and the Board of Examiners for the course. This had the advantage of allowing both teachers and examiners to share views on the format of the proposed examination paper, depth of treatment and emphasis on the three themes.

Towards the latter part of the programme, a few teachers seemed to feel less need to attend the meetings. Some evidently felt that, having 'picked up the swing' of the course, further interchange and discussion was of less importance than remaining at school. While they found the sense of collegiality within the in-service groups appealing, they did not see the meetings as likely to provide any further insights in relation to their own teaching of the course. However, these teachers remained in the minority; overall, attitudes toward the in-service courses continued to be very positive and most teachers participated enthusiastically.

One noticeable effect of the in-service meetings was the sense of shared purpose and group identity which developed and remained with the first cohort of teachers. These teachers quickly came to identify closely with each other and with the course developers, thereby giving a feeling of cohesion and moral support, a feature which proved useful when anxieties and insecurities arose in relation to novel aspects of the course.

5.2.2 Appropriateness of the Model

Two broadly constrasting approaches aimed at supporting teachers involved in major curricular change may be identified. Under the first, teachers would receive carefully structured, intensive in-service preparation on all aspects of the innovation (including the philosophy, aims, content and teaching methods to be employed) from experts familiar with the new curriculum. The teachers would then be expected to implement the curriculum, often without ongoing support. The second approach, increasingly used in recent years, is based more on participation and joint problem-solving. In this approach, teachers are involved in the innovation at the earliest stage of development and are encouraged to explore the problems of implementing the change and to develop their own ideas and strategies. Course leaders in such cases are generally less directive and attempt to encourage teacher initiative in response to the needs they perceive themselves. In-service support under this approach typically extends over a relatively long period and throughout the pilot introduction of the course or innovation.

The Physical Science in-service programme was based more on the second of these models. From the outset the teachers were encouraged to participate in tackling the problems of implementation with the assistance of those organising the course. There was no attempt to impose on them any particular way of doing things, and most meetings were planned on the basis of suggestions from participating teachers. However, the course developers, who were naturally aware of the details of the course and its associated materials and sensitive to the various political and administrative difficulties likely to arise, did provide appropriate and effective leadership where necessary. In general, however, there were deliberate efforts to maximise teacher participation in the meetings.

This approach was clearly appreciated by all of those involved and was one reason for the positive reactions of

teachers to the meetings. The model encouraged the teachers to take an active role, sharing in the planning and evaluation of the course and its implementation from the outset. It also reduced the feeling of threat, which is often associated with innovations of this scale, by ensuring that the teachers played a definite and co-operative part in determining how the course would be taught and evaluated. The participatory planning approach also helped to avoid the danger that teachers might perceive the in-service support to be irrelevant to their immediate concerns.

There were few indications from teachers that the model of in-service used was inappropriate in any significant way. The arrangement of one- or two-day meetings at regular intervals proved satisfactory, though some teachers felt that less time might have been needed for the meetings after the initial sessions. However, the model did pose some difficulties for the organisers of the meetings. While teachers certainly contributed suggestions for forthcoming sessions, the details of forward planning were often left to the convenors. It was difficult for teachers to anticipate needs which might arise in relation to later units of the course; indeed many teachers apparently found it difficult to read the teachers' guides in any detail before teaching the units. It was not common for teachers to request help with, or even to devote much time to discussing, alternative teaching strategies. There were occasions, however, when teachers did refer to the difficulty in coping with students of varying background in science or in handling the novel nature of the discussion techniques suggested during the course. There was also acceptance that topics such as electronics, ceramics and polymers contained content which would be new to the most teachers at this level. But teachers seemed to feel that they could either deal with these problems themselves, or else avoid them by judicious selection of the optional units to be offered to their students. The course developers themselves held strongly to the view that they ought not impose ideas on the teachers by 'telling them their job'. Nor did they believe that there were any particular teaching

strategies that should be recommended for specific parts of the course. Rather, they expected that normal professional interest, prompted by suggestions in the written materials as well as by the new content in some units, would lead the teachers to explore alternative strategies and to seek whatever additional background they needed.

Most teachers appeared well satisfied with the form and scope of the in-service programme which they generally praised highly. In summary, the in-service meetings were seen by teachers as being effective in providing opportunities for

(a) regular communication between the teachers and the Department's officers responsible for implementation;

(b) developing understanding of the philosophy and aims of the course;

(c) discussion of particular problems of content and organisation emerging in the units being taught; and

(d) trying-out some of the unfamiliar experiments specified in particular units before they were encountered in their own teaching.

5.2.3 Ongoing In-service Support

The in-service programme was aimed at assisting teachers in the initial years of implementing the new course. A single introductory in-service meeting for those who planned to teach Physical Science in 1980 was held towards the end of 1979. It was explained to them that it would not be possible to continue formal in-service meetings beyond that point. Instead, it was felt to be more appropriate at this stage for teachers themselves to take responsibility, at a regional level, for organising local meetings. However, the earlier idea with 'geographic groups' of teachers had not been very successful and some of the incoming teachers expressed disappointment that they would not have the benefit of centrally organised meetings[1].

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[1] For the most part, the suggestion for local meetings organised by teachers has not been acted upon.

Some were more fortunate than others in that there were already experienced teachers of Physical Science in their schools: the problem was more apparent with teachers from schools where the course was first adopted in 1980.

However the Education Department felt that it would be neither possible nor appropriate to continue to allocate large scale resources indefinitely to the task of in-service meetings.

The first and second cohorts of teachers expressed satisfaction with the length of the in-service programme and were quite happy to discontinue them at this stage.

5.3 PHYSICAL SCIENCE IN ACTION IN THE FIRST TRIAL SCHOOLS

This section seeks to examine some of the more important issues surrounding the way the new course was implemented during 1978 and 1979 in the first groups of schools. The discussion is based on data gathered by the evaluators during visits and observations in the schools as well as on the responses to a series of student and teacher questionnaires.

5.3.1 School Resources and Laboratory Equipment

Virtually all of the teachers were satisfied with the resources available for teaching the course. Generally, laboratory facilities were considered quite adequate and most of the necessary equipment was readily available or easily constructed. For some activities, teachers did encounter minor problems in obtaining suitable materials. There was a more serious problem with some of the optional units, notably Electronics and Sound and Light, where specific pieces of key apparatus (such as cathode ray oscilloscopes) were not always available in sufficient numbers. Nevertheless, the situation overall was clearly accepted by teachers as satisfactory, as Government schools were usually supplied with items not already in the school.

Teacher's guides and student resource books for each unit of the course were generally available when required, though in the first year only a few of the optional units had been completed and printed. Partly for supply reasons and partly to facilitate the in-service programme it was suggested to teachers that they should commence with Materials, Properties and Structures. By the time most teachers had finished that unit, there was a sufficient quantity of other core units available to permit teachers to follow whatever sequence they wished.

Overall, the only significant problem with resources lay with the availability and use of audio-visual materials. The problem here was twofold. Firstly access to films and other aids was quite difficult in a majority of schools. Some schools were more fortunate in this regard than others. Secondly, teachers were not always familiar in advance with the content of those materials and were sometimes reluctant to spend time ordering films or slides which might not be really suitable for the topics under discussion. Curriculum Branch Officers subsequently responded by providing further information about most of the basic films, a service most teachers found to be particularly helpful.

5.3.2 Supplementary Reading Materials

Most of the teachers established class-libraries with at least one copy of each of a variety of suitable reference texts. School library resources were also reported as being adequate in most schools.

However, their efforts to encourage students to supplement the information from their resource books with readings from other references were not always successful. Though some teachers reported an increasing willingness and general competence on the part of students to work with supplementary texts, the majority of teachers and students reported that little use was made of other science resource

books. This appears to have been due, at least in part, to the inability of many students to cope with the books commonly available, partly because of nomenclature variation from one text to another. Many teachers therefore resorted to providing additional notes to supplement the students' resource books.

Students do not use reference material nearly enough. They seem to wait for teacher direction as to which section they should read.

- Teacher

The reference book system is very difficult. Sometimes I prepare notes. At other times I ask the students to copy from books.

- Teacher

Actually I'm finding that kids, by the time they get to Year 11 are really good at libraries. I don't know what it's like in your school but our kids start using references in Year 8 and by the time they get to Year 11 they're crash hot in using the library.

- Teacher

The general feeling among teachers and students was that the lack of a text book suitable for the course was a significant handicap. Some teachers felt that the student resource book should be expanded to contain more text material. However, others felt it would be preferable for teachers themselves to work from a small set of reference texts, while guiding the students more closely in the choice of specific readings. Students generally supported this latter idea, but asked that more use be made of guide questions which could serve to focus their reading.

5.3.3 Using the Guides and Resource-books

I followed the book to the letter. I had to try everything to see if it was useful

- Teacher

I think that the teachers' guides are very important first time through.

- Teacher

In the future I'd be inclined to leave out sections and would probably take parts of the materials and slot them in with other material so that I'd end up with one great big guide rather than separate guides.
- Teacher

For the most part, teachers tended to follow the content and sequence suggested by the guides for each of the units. In general this appeared to be a satisfactory procedure. The main difficulty reported by many teachers was lack of adequate time to cover the topics in sufficient depth. However, there were indications that teachers frequently interpreted the suggested student outcomes in a far more detailed way than was intended by the course writers. Indeed, some teachers reported that they found it difficult to treat many of the concepts of the course in any less rigorous way than they typically did in their Chemistry or Physics classes. On the other hand, those who decided early to accept more elementary models or explanations regarding these concepts did experience less of a problem in covering the course. Nonetheless, there was virtual unanimity regarding the perceived 'overload' in a number of the core units.

Figure 5.1 shows the sequences of units chosen by teachers. Comments from the teachers revealed general satisfaction with the flexibility provided by the unit structure. In almost all cases the choice of optional units was made by the teacher, though a few evidently did consult students about the choices to be made. While most teachers noted that they would have preferred to have been able to allow some free selection by the students, it was recognised that this was not likely to be feasible in the first few years of the new course.

The choice of the Science and Society option in a high proportion of classes arose partly because many of the teachers felt that it made an important contribution to the cultural theme of the course and partly because it was relatively easy to dovetail with some of the core units. Another factor was that some of the other options were perceived as being more difficult

Figure 5.1 :SEQUENCES OF UNITS PLANNED BY FIRST PHYISCAL SCIENCE TEACHERS

TEACHER	1ST	2ND	3RD	4TH	5TH	6TH	7TH
1	M	CC	CI	W	ET	CB	SS
2/3	M	CC	CI SS	CB	ET W/E		
4	M	CC	CI	W SS	ET	CB	SS
5	M	CC	CI	ET	SL	W	CB
6	M	CC	CI	ET	E	CB	CP
7	M	CC	CI	ET	CB SS	W/CP	
8	M	CC	CI	ET	CB	W	SS
9	M	CC	W	CI	ET	CB	EF
10	M	CC	W	CI	ET	CB	SS
11	M	CC	W	ET	CB	CI	SS
12	M	CC	ET	CB	SL	CI	SS
13	M	CC	ET	CI	W	CB	SS
14	M	CC	ET	SL	CI	CB	CP
15	M	CC	CB	ET	CI	CP	SS
16	M	CC	CB	ET	CI	W	
17	M	CC	SL	CI	ET SS	CB	
18	M	W	CC	CI	ET	CB	EF
19	M	CI SS	CC SS	ET	CB	W	

Core Units

M: Materials Properties and Structures
CC: Chemical Change
CI: Change and Interaction
ET: Energy Transformations
CB: Carbon-based Materials

Optional Units

W: Water and Other Liquids
CP: Ceramics and Polymers
SS: Science and Society
SL: Sound and Light
E: Electronics
EF: Engines and Fuels

to organise and teach, due to equipment needs and to the nature of the science content. Water and Other Liquids was also well received by teachers and students as a unit having a good deal of immediate relevance to the Western Australian environment.

The case-studies, which formed an integral part of the Chemical Change unit, were handled in a variety of different ways. There was a special difficulty here in that resource books for the suggested case-studies were not available to schools during the first year of the course. A few teachers used their own resources and organised industrial visits but the majority left the case-studies until the latter part of the course. However, the emphasis given to case-studies varied considerably from one teacher to another. At one extreme some included a comprehensive study of one or two industries; at the other there were teachers who simply let students read about the industry from written resource literature as an assignment. The latter group either saw the case-studies as a relatively minor aspect of the overall course or else simply could not find class-time to deal fully with them.

5.3.4 Teaching Strategies

The greatest challenges in teaching the course seemed to arise from the need to cater to a wide range of student backgrounds and abilities in science. The problem varied from school to school depending on the student intake, but all teachers reported that they had to make greater efforts to ensure that all students were able to cope with the content of the course. This challenge was increased by the fact that students were expected to use reference books much more than students in most other science subjects. As indicated in 5.3.2 above, the students had difficulty in this regard and most teachers gave a considerable emphasis instead to direct teaching of concepts and other science content. This was supplemented in many cases by worksheets containing summaries of the main

theoretical information, student questions and assignments. The supplementary readings in the resource books were also read by the majority of students.

Despite the pressures of time faced by the teachers it is noteworthy that the great majority of them attempted to do most of the suggested laboratory demonstrations and activities. In general these proved very popular among both students and teachers. The only negative aspect which emerged in relation to the practical activities arose with students who did not see the purpose of some of them. It was noticeable from comments of a number of the teachers that they too were sometimes uncertain about the purpose and therefore the usefulness of some of the simple activities. However, this view was not shared by other teachers and it would seem that this difference in viewpoint was due to the varying perspectives held by teachers. Some felt that there was little point in getting students to do experiments where no precision in result was expected. Other teachers felt that simple demonstrations of properties and phenomena were useful in developing students' understanding of the principle or concept under study. Overall, however, there was a strong commitment shown to the laboratory work by all teachers, and students were generally supportive of this emphasis in their course.

They can't handle discussion. I don't reckon they do enough in lower school

- Teacher

On the science and society aspect, kids are more prepared to listen than to actually participate.

- Teacher

I would say primarily for the reason of shortage of time...I gave it (discussion) away.

- Teacher

They soon learn discussion skills. I've got no problems at all and I've only got a class of 12 kids so every kid is very conspicuous.

- Teacher

I think it's (discussion) very much a developed skills...they can develop it in one or two years quite adequately.

- Teacher

In a small number of classes there was a considerable emphasis on other kinds of student activities involving small-group and class discussion and library research. But in most classes this did not occur much. In general, the strategies adopted fitted much more closely the expository model of teaching rather than enquiry approaches. An exception to this in some classes occurred in the area of science and society. Here the students found opportunities to explore controversial issues and were encouraged by their teachers to seek out information on which to base their arguments. Most students commented very favourably on this aspect of their course. Laboratory work and problem solving which most students experienced throughout did provide opportunities for enquiry approaches to learning, but overall the strategies used by the great majority of teachers did not place explicit emphasis on enquiry methods.

For reasons already discussed (5.3.1), less than thirty percent of teachers reported using films or other audio-visual material to any signficant extent. On the other hand, visits to industrial sites and the emphasis on written essays based on student assignments were used by most teacher and were regarded as a useful aspect of the overall teaching approach by both teachers and students. About half of the teachers in the first trial classes encouraged students to do library and other research in relation to student assignments of this type.

The overall picture which emerged indicated that teachers tended to concentrate on a mixture of direct class teaching and practical work in which the guidelines in the resource books were usually closely followed. Only a few teachers used enquiry modes of teaching (involving, for example, open-ended experimentation and discussion) to any significant

degree, but in such cases they were very pleased with the effects in terms of student response. The resource books provided the major source of reading for the great majority of students and supplementary reading was usually confined to notes provided by the teachers. There was little direct emphasis by teachers on enquiry approaches to learning, but practical activities and students assignments did provide opportunities for students to develop skills in interpretation and application of concepts and principles.

5.3.5 Student Evaluation Procedures

Most teachers used a variety of student evaluation procedures. These included periodic written examinations, short tests at the end of individual units, essays and laboratory reports. They also attempted to evaluate students' attainments in aspects such as laboratory work, understanding and interpretation of phenomena and principles, as well as the three themes interwoven through the course. There was a general inclination, particularly in written tests, to focus on the chemical and physical principles and factual scientific content -- along the lines of typical chemistry or physics tests -- though some teachers did put considerable effort into devising questions which reflected the emphasis on real-world examples. (There was also some sharing of possible evaluation questions among schools within the geographic groups as mentioned earlier). It was clear that the teachers felt that their major responsibility was to prepare students effectively for the Tertiary Admissions Examination and most evaluation procedures were designed to contribute, in both the diagnostic and assessment senses, to that end.

Evaluation of the course should be as for the TAE. I think you should model your evaluation in this way as students need training for the exam.

- Teacher

It is unfair to evaluate students for discussion, participation or practical technique. These skills develop gradually over the two years and can be encouraged incidentally.

- Teacher

It is difficult to assess practical work. The teacher needs to discuss activity questions on the spot and there is thus little point in marking it.

- Teacher

Indeed, as one might expect, the final examination was a central part of teachers' and students' concerns throughout the two-year programme and the perceptions held about the likely nature of the paper played a major part in the strategies of all those directly involved. Unlike those teaching the existing TAE subjects the Physical Science teachers initially had no real yardstick (in the form of past examination questions) against which to set their standards. The trial paper produced by the examination panel, in the latter part of 1978, provided teachers with a model on which to focus their teaching and evaluation. The teachers, on the whole, found the examples of questions in that paper to be a helpful guide.

Reactions of teachers to the first TAE paper were generally positive. The only reservations appeared to arise from the level of quantitative work expected of the candidates. Interestingly, in view of the teachers' often expressed concern about the danger of the examination making too much demand in this regard, there appeared to be a degree of surprise among many teachers at the low priority placed on this aspect in the paper. From comments and reactions of a number of teachers it appeared that teachers tended to interpret the term "problem-solving" as meaning quantitative calculation, whereas the examiners had interpreted the term in a much broader sense to include interpretation and application of science concepts and principles to experimental and real-life situations.

Apart from this, the general feeling of teachers was one of considerable satisfaction with the style and content of the paper which they felt fairly reflected the philosophy and aims of the course.

5.5 CONCLUDING COMMENTS

The general view of teachers about the implementation processes was very positive both in relation to the means by which the new course was disseminated to schools and to the practicability of implementing the course in the classroom situation. In respect of the in-service programme teachers found the continuing series of meetings most useful, even though it involved their absence from schools for a significant number of days.

The availability of teacher's guides and resource books was considered vital in the interpretation of the syllabus statement and the majority of teachers were happy to follow the details and suggested sequence of these materials fairly closely. A number of teachers commented that, with increased experience of the structure and content of the various units, they intended to adapt the content and sequence considerably in future years. There was also evidence, in some instances, that teachers' styles of presenting the course were changing as they became more attuned to the objectives of the course and to the advantages of incorporating a broader range of teaching methods than were used by most of them in their Chemistry or Physics classes. However, in the majority of cases, there was a natural tendency for teachers to follow methods (mainly expository) similar to those used in teaching the latter subjects. Lack of experience with other methods of teaching and the pressures of organising and teaching the new course for the first time were major factors in this regard.

CHAPTER 6: PERCEPTIONS RELATING TO THE WRITTEN MATERIALS

6.1 INTRODUCTION

The first trial editions of the teachers' guides and student resource-books were issued in the latter part of 1977 to coincide with the start of the in-service programme for Physical Science teachers in the trial schools. At this stage, considerable interest in the materials led to a variety of comments and reactions by teachers, consultants and other tertiary personnel about the materials and the course itself. Subsequent use of the materials in schools during 1978 and 1979 produced a wide range of comments from Physical Science teachers and students. In this chapter we examine the issues arising in relation to the written materials, focusing on the perspectives of the following key groups:

- the project's tertiary-level consultants as well as other academic scientists not directly involved in the course development process
- the teachers of Physical Science in the adopting schools
- Year 11 and Year 12 students taking Physical Science.

Since the general perspectives differed at times quite markedly from one group to another, with different issues seen as particularly relevant by each group, it is useful to look separately at the reactions of the groups.

6.2 REACTIONS AMONG TERTIARY SCIENCE SPECIALISTS

As might be expected the range of attitudes expressed by tertiary science specialists was considerable and sometimes indicated a strong divergence of values and professional judgements. These views related mainly to three aspects of the materials and the course itself:

(i) the rationale and aims of the course

(ii) the appropriateness of the overall design of the course and the written materials

(iii) the content of the written materials.

6.2.1 Rationale and Aims of the Course

Though the general aims of the course and the proposed syllabus had been discussed at some length within the S.S.E.C.C. and agreement had been reached by the various parties prior to the establishment of the course, it was clear from the many comments and queries raised later by tertiary scientists when the written materials were first published that these aspects remained as lively issues; indeed the matters raised by the group reflected essentially the same concerns as had been raised by them prior to the establishment of the course. Some of those interviewed were clearly strongly opposed to the course on philosophical and practical grounds. Others were strongly in support of the course. Most of those interviewed accepted the need for a course which could provide broad coverage of the physical sciences in a way that would be appropriate for the average upper-school student and in this context were satisfied that the new course was a worthwhile innnovation. There was general acceptance too of the wider aims of the course as represented by the technological and cultural themes included along with the science content. Among those opposed to the rationale and general orientation of the course, there was some feeling that modifications to the existing Chemistry and Physics courses would have been adequate to meet most of the needs seen by the schools and that Physical Science would not provide a satisfactory alternative to the existing subjects.

On the other hand there were a number of enthusiastic supporters within the tertiary science sector who expressed the hope that some of the philosophy and approaches of the new course would eventually be picked up by teachers of Chemistry and Physics, which subjects they saw as being undesirably narrow in focus.

A view shared by almost all tertiary science staff, contacted in this evaluation study, was that Physical Science would not in itself provide sufficient preparation for courses leading to major studies in the physical sciences. There was, however, some difference of opinion about its suitability for other science-related courses which did not involve a physical science major. In general, the feeling was that this issue would be resolved when students, emerging from schools after completion of the course, undertook such courses.

6.2.2 Overall Design of the Course and Written Materials

Even among those supportive of the general aims of the course there were varied reactions to the structure and content that became operationalised through the syllabus statement, teachers' guides, and resource books.. Generally, there was strong support for the inclusion of laboratory and other student activities designed to show the relationship of science to everyday life. In this regard the inclusion of studies of local industries as examples of the application of scientific principles and knowledge was welcomed by most. The only reservations related to the danger seen by some that the subject might become dominated by a preoccupation with particular local applications to the detriment of more general understandings.

The broad conceptual areas -- materials, energy and change -- which provided the main structural basis of the course and the individual units into which it was sub-divided were accepted as a valid and useful framework. The only significant problem that was raised related to the unit Change and Interaction which a few academics felt to be artificially designed in terms of the examples chosen from the fields of chemistry and physics.

The other aspects of the course which received generally positive comments were the core-plus-options structure and the effort made within the syllabus and the written materials to incorporate topics and exemplars which were

'up-to-date' and relevant. In this regard some of the optional units such as Ceramics and Polymers and Electronics were welcomed almost universally.

One aspect on which the different disciplines separated sharply was the balance of chemistry and physics content within the course. Most of the physics specialists felt strongly that there was an imbalance in the amount of physics and chemistry in the course with too much emphasis on 'pure' chemistry in the core units such as Chemical Change and Carbon-based Materials, and too great a stress on chemical structures and properties in the unit Materials, Properties and Structures. While chemists did express some concern over the considerable depth of treatment given to chemical concepts at various points of the course, there was little suggestion by them that there should be a greater proportion of physics included.

6.2.3 Content of the Unit Guides and Resource-books

I have no reservations about concepts of the course. The style and content of the resource books are appropriate and up to expectations.
- Tertiary Science Academic

The materials do not reflect the philosophy of the course which involves giving experience with science with minimum formality.
- Tertiary Science Academic

A wide variety of views were held among tertiary academics about detailed aspects of the content. Much of the detailed comment relevant to the continuing development of the written materials was fed back to the course writers by these academics at the time and need not be addressed here. It may be

useful, however, to discuss two issues which appeared to have had a more general significance to those concerned.

(i) There appeared to be some confusion about the intended structure of the student resource-books among some of those commenting on them. A number of those interviewed were unsure whether they were intended to function essentially as textbooks or, as their name implied, simply as supplementary resource materials to guide the students. This confusion appears to have arisen partly from the content and presentation of the resource books themselves. In some cases the books included considerable and detailed background reading for certain sections but very little (or none) for others. This led to criticism of what some saw as weaknesses in sequencing and imbalances in the depth of treatment given to various topics. Criticism in this regard varied considerably from one unit to another, some being seen as more coherently presented than others.

(ii) In relation to perceptions about the appropriateness of the content of the written materials there was a noticeably sharp division in the perceptions of the science academics concerned. Some felt that there were a number of fundamental deficiences in these materials. They argued that the presentation of scientific concepts was too similar to that of the existing Chemistry and Physics courses and that a radically different approach to such concepts would have been more appropriate in meeting the stated aims of the course. There was also criticism of the choice of some exemplars of industrial applications, sequencing and articulation of concepts and other aspects. This view was sharply at odds with that of a larger group who expressed strong support for the general format and content of the materials. While those in the latter group pointed to a number of

aspects of the materials which in their eyes, required modification or improvement they accepted that such modifications could be incorporated in the process of development envisaged when the trial editions would be revised.

On one matter there was agreement by most academics, and that related to the amount of conceptual content within each unit. There was a general concern that the effect of this might be to force teachers to neglect some of the teaching strategies such as practical activities, discussion and case-studies because of pressures of time[1].

6.3 TEACHERS REACTIONS TO THE COURSE AND THE WRITTEN MATERIALS

Overall, initial reaction of Physical Science teachers to the new course and the written materials was strongly favourable. Many had taken the initiative in having the course adopted in their schools and some had been involved in the development of the course or its written materials. The main strengths of the course were perceived by the teachers to include:

(i) the provision of an interesting physical science alternative which did not place overly strong emphasis on quantitative treatment, and

(ii) the emphasis on applications of science in society and technology and the effort to relate the study of science more to student needs and interests.

It was firmly believed by most teachers that the course would have wider intrinsic appeal among upper-school students than had been the case in recent years for Chemistry or Physics. Though many of the

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1 It is of interest to note that teachers shared the above view that there was too much conceptual content in some units but believed that this had resulted partly from the need to satisfy requirements of the tertiary institutions.

teachers did experience various difficulties in the early stages of implementation of the course and in the use of the written materials, their overall view that the course was serving a useful purpose remained constant throughout the trial period. Most were clearly enthusiastic about being involved in the formative development of the trial materials and contributed a wide range of comments about all aspects of the course.

Most of us like teaching Physical Science because in a sense we wanted to. It's given us an opportunity to do things that we've felt maybe we ought to have done somewhere else, but haven't had the opportunity to do.
- Teacher

I think its a course we've waited for for years.
- Teacher

Well I think its the best thought out, most consistent and most developed science course that we've come across. I think it was thought out very carefully with the idea of keeping the kids interested by balancing the amount of weight given to each topic very carefully and what its social relevance is.
- Teacher

6.3.1 Appropriateness of Content

By comparison it's probably not as hard as Physics and Chemistry together, but I find myself it's a subject that is quite strong.
- Teacher

Teachers' attitudes or reactions to the content of the course were related generally to

- -the ease or difficulty of teaching the content to the students in their classes
- -the level of interest evoked in the students
- -the matching of the content to the stated outcomes for the various sections.

In general, reaction to the content and student activities was very favourable, despite difficulties the teachers may have experienced in teaching some aspects. The student activities were considered for the most part to be very suitable, although some exceptions were quoted. There was

negative reaction to some parts of content felt to be boring or indigestible for their students. In this context many teachers reported that the reading level of some of the background material was inappropriately high for their students. Considerable enthusiasm was shown for the inclusion of laboratory activities showing applications of scientific laws and concepts in everyday situations. There was growing interest shown by most teachers in the three themes of the course, as indicated by the popularity of the optional unit Science and Society. This interest appeared to strengthen as teachers became more familiar with these aspects of the course.

Well, I felt very comfortable about it. I think its great for educating kids, giving them a technical background and yet at the same time we're getting them to take an interest in science and society aspect, discussions, research assignments and all that.

- Teacher

It would be possible to delete a number of difficult concepts (dipoles, hybridization...) and still enable students to appreciate the uses of materials in terms of their properties.

- Teacher

The core-plus-options structure of the course appealed to virtually all of the teachers. The structuring of the core material into units corresponding to the conceptual scheme materials, energy and change evoked no strong reaction either way and it appeared that this aspect of the course's structure was of less significance than the inclusion of the three themes. Optional units received favourable comment from those who chose the various units. However, it was clear that some of these units were perceived as being harder to teach than others. This was due partly to the inclusion of novel content and activities and partly because, for some units, the student activities required a good deal of extra equipment not easily available in some schools. Most teachers would have liked to incorporate more optional material in the course but felt that the time required to cover the core units precluded this.

I do like the idea of being able to swap the order so next time you can swap it around a little bit if you think it would be better and you can slot in an option where you want it to go.

- Teacher

6.3.2 Sequencing and Development of Concepts

You still have to teach basic concepts. They are difficult concepts and we waste time with the Physics and Chemistry kids as well. Some of them still don't grasp what you mean and this is the problem we are having with Physical Science.

- Teacher

Although all teachers commenced with the unit Materials Properties and Structures they tended to vary in their sequencing of the core and optional units thereafter. None appeared to encounter any major difficulties in this but a number did cite some specific problems in relation to sequencing and developing of concepts. Because of the modular structure of the course and the large number of concepts introduced within each unit, teachers were concerned at the difficulty experienced by students in grasping and consolidating such concepts in the short time available. There were often sudden changes within parts of a unit and in the nature of the concepts being developed from one unit to another. It was widely felt that students would quickly forget concepts since they had too little opportunity to revisit or otherwise reinforce them. Many teachers therefore took deliberate steps to reserve some considerable time in the closing stages of Year 12 to revise and integrate the concepts dealt with in the various units.

6.3.3 Depth of Treatment

The depth of treatment depends on the ability of your class. In Year 11 I did not treat topics to the depth I should have e.g. electron configuration needs to be done in some detail as this is needed to explain many aspects of the course.

- Teacher

The problem of deciding to what depth one should treat particular topics lay at the heart of most teachers' concerns in the early stages of implementation. While each topic was prefaced in the guides by a listing of expected outcomes and an indication was given of the nature of the content for each section, teachers often found it difficult to decide on the appropriate depth of treatment. The reasons reported for this difficulty were

- insufficient specification of the outcomes.
- uncertainty about the importance of concepts which might be required in later units.
- uncertainty about the nature of the first tertiary admissions examination.

A number of 'guide questions' were provided within each of the units but many teachers felt from an early stage that these, while useful, were an insufficient guide to depth of treatment. A related problem had to do with the pre-requisite knowledge and skills assumed by the units. In some cases, teachers found these demands to be rather more than they had anticipated, and reported that they had to revise and develop basic concepts and skills with their students before starting the units. The principal effect of this was a persisting sense of insecurity among some of the teachers. Their concern was compounded later when they found there was insufficient time to cover the content of some units. This problem was eased to some degree as the course progressed and there were opportunities for discussion with fellow teachers, the course developers and members of the examining panel. The preparation and circulation of a trial examination paper in Physical Science at the end of 1978 was of particular value in this regard, and most teachers reported being reassured by the nature and level of questions set.

The required outcomes in the Teachers' Guides do not necessarily match the material to be covered. Too much is left up to the teacher, there is a need for a more specific statement of course aims and depth of treatment needed.

- Teacher

The behavioral outcomes as stated are quite useful in deciding how deeply to treat sections.

- Teacher

I think its part of the Physics and Chemistry hangover....we've been conditioned to produce a certain degree of or a certain depth of treatment for those two which is not appropriate in Physical Science.

- Teacher

Discussion of problems concerning depth of treatment occurred frequently at in-service meetings and it became clear that some teachers were interpreting unit objectives very differently from others. While a number tended to teach topics in much the same way as they would for TAE Chemistry or Physics classes, others were quite satisfied to treat the Physical Science topics in a simpler, often qualitative, way. The interaction among teachers on this aspect was a central feature of the inservice sessions and was obviously satisfying to the teachers.

One clear outcome of teachers' early experience with the course was their recognition that Physical Science was by no means a 'soft' alternative and that students without a solid background in science would continue to have difficulty with it. It was the opinion of most teachers that only those who had achieved Advanced level grades for Science in Year 10 would be able to complete the course satisfactorily. Some teachers, however, believed that well motivated students with an Intermediate level of achievement in Year 10 would be able to cope. In general, though, the consensus of opinion among teachers was that Physical Science was conceptually demanding and that it was inappropriate for it to be looked upon as an easy alternative for students disinterested in science or unable to cope with the existing TAE physical science subjects.

6.4 STUDENT PERSPECTIVES

> *Physical Science is good because it relates basic chemistry and physics to society. This I think is more useful to us than just chemistry and physics facts.*
>
> *- Student*

Although the students brought with them definite pre-conceptions of the course and of its content (see Chapter 4), these were later modified, sometimes quite markedly, in the light of their experiences. In the main the students' reactions were very favourable to the course and the written materials. They liked the idea of a broad study of chemistry and physics and attached considerable value to a number of aspects of the course including:

- the relevance which they perceived the course content to have the world around them.
- the emphasis on practical activities throughout.
- the reduced emphasis on quantitative approaches in the treatment of science concepts.
- the opportunities to explore issues relating to the cultural impact of science and its effects on society.

Within this overall context, students did raise a number of issues relating to the course which caused them some problems or which they felt might be of value in any further development of the course and the resource books. These are discussed with reference to the following aspects:

Conceptual content
Coherence and flow
Balance of content
Student activities
Relative popularity of units
Structure and format of student resource-books
Interest and relevance of the course.

6.4.1 Conceptual Content

Physical Science makes sense of all the equations and calculations. You can see why they are there.
- Student

Sometimes too much information is given in too little time. This makes it hard to remember and understand.
- Student

The course is trying to put too much into the short time available.
- Student

Problems are O.K. once you have had practice.
- Student

A good subject, although it should have less mathematics in it.
- Student

Most of the students were evidently satisfied with their own handling of the conceptual material in the resource books, although many would have preferred more time on some of the major concepts. While a few students felt that the material covered was not sufficiently demanding, the general view was that the course had attempted to cover too much too quickly. A significant proportion reported that they had considerable difficulty with the quantitative aspects and with the emphasis (particularly in Chemical Change) on chemical formulae and equations. These latter aspects of chemistry caused special difficulties for students who had not studied Advanced-level Science in Year 10.

6.4.2 Coherence and Flow

The 'overview' at the front of each resource book was designed to give an indication of the scope and structure of the unit, but this was apparently insufficient in some cases to prevent students becoming confused by what they perceived as the constant jumping-around in the sequencing of content. This was

particularly so for students who had felt too hurried in earlier units and who feared they would fall further behind in later units.

I think the course doesn't follow on. You do an activity and then you go onto something else. You should stick to one topic a bit longer.

- Student

The course is confusing because we don't know what topic is coming next.

- Student

The self-contained nature of the units, while having obvious advantages, was seen as a potential problem by some students. A number expressed concern that in switching to a new unit they would find it difficult to consolidate the knowledge gained in earlier units. To some extent this concern subsided as the course progressed and students began to develop a more integrated sense of the main themes and concepts as they were re-visited at different places in the course.

6.4.3 Relative Popularity of Units

Students preferred those units which they perceived as being relevant and not too difficult. Chemical Change was generally perceived by students to be the most difficult unit. They liked the Change and Interaction unit because of the balance, interest and appropriateness in terms of difficulty. Those students who did the options Science and Society and Water and Other Liquids found these to be less difficult than Carbon-based Materials and Energy Transformations. Materials, Properties and Structures received mixed reactions in relation to both difficulty and appropriateness of content.

I liked Chemical Change because I like Chemistry. It was not too hard.

- Student

I did not like Chemical Change but enjoyed all other topics.

- Student

Change and Interaction is more interesting than the first two topics (Materials...and Chemical Change) because of its practical implications. It is more what I had imagined Physical Science would be like
- Student

Energy Transformations was an extremely interesting topic, practical and relevant to our everday life.
- Student

6.4.4 Balance of Content

With respect to the perceived balance of physics and chemistry content in the course, student reaction was divided. A minority, those who particularly liked chemistry, were generally satisfied, but the majority were unhappy with what they saw as an excessive emphasis on chemistry at the expense of physics. This latter feeling may have been related to the fact that in most schools the first two units taught were Materials, Properties and Structures and Chemical Change. The second of these was oriented almost totally to chemistry; it was also seen by most students as being very difficult. At this stage some students were openly disappointed with the course and criticised it as being 'just another chemistry course'. As with the early concern with the apparent disjointedness of units, dissatisfaction with the initial focus on chemistry tended to moderate as the students worked through other units.

6.4.5 Student Activities

Overall, the laboratory exercises were very favourably received, both in terms of intrinsic interest and because of their value in helping illustrate or develop important concepts and principles. However, this generally positive reaction was tempered by criticisms of particular activities. Criticisms were made of a small proportion of the activities that:

- seemed trivial (or meaningless)
- were too long, were difficult to follow, or which did not work the way they were intended.

It was apparent that the manner in which the teacher used an activity had an influence on the perceptions of students. Some teachers were dissatisfied with short qualitative exercises and preferred activities which allowed for rigorous measurement; this appeared often to be reflected in the attitudes of their students.

I like doing experiments, but not ones where hardly anything happens.

- Student

I thought all of the experiments were worth doing.

- Student

Practical work is 'the best'.

- Student

Reactions to non-laboratory activities and their associated guide questions were more mixed. Some were praised but a number of students reported that questions relating to other activities were difficult to research and answer, due partly to the earlier-discussed uncertainty about depth of treatment required. In addition, students felt that they were not learning much (relevant to the final examination) from some of the activities and guide questions. The students, like many of their teachers, were persistently concerned with the final examination and felt insecure when faced with open-ended activities or tasks which did not have an obvious relationship to what they expected to find in the TAE paper.

6.4.6 Structure and Format of Student Resource Books

Students raised a number of issues concerning the structure and format of the resource books. While they all certainly found the books useful, a number of specific problems - some major and others quite minor - coloured their overall attitudes to them.

One general and frequently reported concern was the lack of a formal (standard) text book for the course. Most students were evidently reluctant, or in some cases perhaps unable, to use reference books effectively. Most teachers provided hand-outs and notes as a supplement to the resource books, but this apparently did not entirely meet the deficiency seen by the students.

The identification and separation of reading material within the resource books as 'required' and 'additional' appears to have been only partially successful. The majority of students tended to ignore readings in the 'additional' category, evidently seeing anything not clearly necessary for the course as irrelevant. Some students also found the readings in a number of sections difficult to comprehend. Thus, while the resource books were considered useful in relation to student activities and guide-questions, they were seen as being of less value as a source of extra reading on science. Most students apparently relied heavily on their teachers to provide the necessary background material and elaboration needed for adequate understanding.

Asked what improvements they would like to see in the resource books, students suggested more attractive lay-out, better guidance within and between sections of the units, more explanation of the relationship between different units, easier reading material, more worked examples, answers to quantitative questions, and a glossary of scientific terminology.

6.4.7 Interest and Relevance

It's much more interesting than just science.
- Student

A good lot of discussion. Teacher lets us have our say. It's good.
- Student

I like the subject because it is relevant to everday things.
- Student

In terms of course content the general level of interest reported by students was fairly high although this varied considerably from student to student and from one unit to another. However, those who found parts of the course to be very difficult tended to lose some of their enthusiasm, at least for a while. Nevertheless, the overall feeling was that many aspects of the course were relevant to everyday experience and to the real world of industry and this was seen as a distinct attraction of the course. The contribution of the 'technological' and 'cultural' themes to the maintenance of interest and a sense of relevance appeared to be quite significant. The emphasis on laboratory activities and the inclusion of visits to industrial sites were also popular with most students.The students remained satisfied throughout with their decision to study Physical Science, despite the various minor criticisms and concerns expressed.

The course was also seen as relevant, but in a more particular sense, by those who wanted to follow careers of tertiary courses needing some background in the physical sciences. This feeling obviously contributed to the high level of motivation shown by most of the students taking the subject.

6.5 CONCLUDING COMMENTS

As described in this chapter, a wide variety of perspectives and reactions to the course and the accompanying trial editions existed among the participants and other interested groups. Overall, however, the reactions within each of the three groups -- tertiary personnel, teachers and students -- were favourable. Some of the tertiary academics had reservations about the content of the materials, and a minority of the students expressed negative views. All the teachers and a large majority of students expressed positive views about the course and the written materials and were happy to have undertaken the course.

CHAPTER 7: SUMMARY AND CONCLUSIONS

7.1 INTRODUCTION

This final chapter summarises the main issues which emerged during early negotiations to establish Physical Science as a full TAE subject, and during the subsequent implementation of the course in the schools in 1978 and 1979. It also briefly reviews the place of the present report in the context of the overall evaluation and raises some issues which may be relevant to the further development of the course. Though the summary makes reference to most of the key issues addressed in earlier chapters, it is not intended to provide a complete account of the complex interrelationships within the array of perspectives held by the various interested parties.

7.2 SUMMARY OF ISSUES

7.2.1 Establishment of Physical Science as a new Subject

(a) Initially, the suggestion for an alternative Tertiary Admissions Examination (TAE) subject for students who did not wish to do both Chemistry and Physics came from the Education Department in response to needs perceived within the schools. One factor influencing this was the fact that many students then studying Chemistry and/or Physics (usually in conjunction with Mathematics 2 and 3) were not proceeding to tertiary studies in these subjects. Another was the need to provide appropriate courses of study for the increasing proportion of the age group who were staying on at school beyond Year 10, but who did not have the same orientation toward tertiary studies.

(b) Earlier consultations with academic scientists in the tertiary institutions revealed little support within this sector for such a change. However, further consultations were held subsequently through the aegis of the Secondary Science

Education Curriculum Committee involving senior academics, senior officers from the Education Department, and teachers' representatives. This committee ultimately recommended the adoption of the Physical Science Course as a TAE and CSE subject.

(c) Though it was agreed by the committee that Physical Science should provide an alternative for students who did not wish to pursue chemistry or physics at the tertiary level, there remained some ambiguity about whether the proposed course would provide an appropriate preparation for a number of science-related tertiary courses.

(d) The agreed rationale, aims and content of the new course were based, with considerable modifications, on the one-year course Man and the Physical World which had been then recently developed in Victoria. Teachers' Guides and Student Resource Books were prepared by the Curriculum Branch of the Education Department with the assistance of specialist content consultants and contract writers.

(e) The majority of science specialists in the tertiary institutions ultimately accepted or welcomed the establishment of the new subject. However, some senior and influential specialists were either not in favour of it, or else disliked the content of the course as represented by the first draft materials.

(f) There was general support from school principals and science teachers for the introduction of the new subject. Most were clearly in favour of the prospect it offered for broadening the range of subjects open to their students, particularly those wishing to study chemistry and physics in a less quantitative fashion or to combine study of one of the biological sciences along with a single course in the physical sciences area.

(g) The tertiary institutions advised schools from the outset that students wishing to take chemistry or physics courses at tertiary level should study these same subjects,

rather, than Physical Science, at the TAE level. Generally, schools took this advice seriously, both in relation to adoption of the new subject, and when counselling students on entry to Year 11.

7.2.2 Materials Development Procedures

(a) The procedures used for the preparation of written materials -- the use of contract writers and consultants working in collaboration with the Curriculum Branch course writers -- were seen as satisfactory by most of those involved. Nevertheless, a number of specific difficulties were encountered in the process. These included delays in getting responses from some of the consultants, all of whom were involved on an honorary basis; the difficulty of incorporating or reconciling the different suggestions and modications proposed for some units; a lack of time in which to return modified sections to the consultants before the units were printed for use in the trial schools; and pressures on the course writers to incorporate more reading material in the resource books than had originally been intended.

(b) A few of the consultants were critical of the writing model used and would have preferred a contracting arrangement whereby the responsibility for preparing first drafts would be given to specialist scientists in the relevant areas. However, the majority of the consultants and teachers appear to have been happy with the writing and review procedures followed.

(c) All of those involved in the development of the resource books expected that the trial versions would be revised for subsequent editions on the basis of feedback from the trial teachers and others involved, and saw this as a major strength of the overall process being used.

7.2.3 Initial Dissemination of the Course

(a) Communication of advance information about the course during 1977 was considered adequate by almost all schools. However, the existence of better developed networks of communication within Government schools appears to have contributed to their higher rate of adoption compared to the non-Government schools.

(b) In 1978, the first year of the trials, 18 Government schools and one non-Government school elected to offer Physical Science enrolling a total of 369 Year 11 students. In 1979 a further 16 schools (including three non-Government schools) joined the group, and the total Year 11 enrolment increased to 688 students.

(c) Factors inhibiting early adoption in non-Government schools included the desire to await information on the progress of the course during the trial phase, staffing and other resource considerations, parental concern or uncertainty regarding the eventual status of the new subject, and the perceived constraints on student choices implied by advice from tertiary institutions. Nevertheless, the majority of non-adopting schools in 1978, whether Government or non-Government, were favourably inclined towards the new course and indicated that they would probably adopt it at some time in the future.

(d) Within the first group of trial schools, science teachers played a significant part in the decision to adopt and these teachers were, for the most part, highly motivated towards successful implementation of the course.

7.2.4 The In-service Programme

(a) For schools which notified their intention to adopt the course in 1978, further information was disseminated through a special programme of in-service meetings for the teachers

involved. This programme, which commenced late in 1977, extended through the first two years of the trial period. All of the teachers involved in the meetings during this time found the programme to be most valuable, particularly in the early stages of implementing the course.

(b) Though the course developers played a key role in the organisation and running of the meetings, they encouraged the teachers to take the initiative in identifying their own needs and suggesting the kinds of support they wanted. The teachers were concerned mostly with problems of organisation, depth of treatment of topics, sequencing within and between units and assessment procedures. They did not express much need for assistance in relation to teaching strategies or scientific background in relation to new science content contained within some units.

(c) Many teachers expressed the view that, despite the flow of written information about the course, they would not have developed as full an understanding of the philosophy and general teaching approach without the discussions and interaction with the course developers and others at the in-service meetings. Another important benefit of the in-service programme was the development of strong group identification among those involved; most teachers derived considerable psychological support from the group and from the opportunities the meetings provided for exchanges of experiences.

(d) The programme was also valued by the teachers because of the opportunities it afforded for

(i) continuing input from the course developers regarding the nature of the course and the details of the units being taught,

(ii) feedback to the Education Department concerning implementation problems, and

(iii) feedback to the external examiners concerning the format and emphases of the forthcoming TAE examination.

(e) Those teachers involved in the in-service found the duration of the programme adequate. However, some felt that the lack of similar support planned for subsequent years might lead to problems for incoming teachers particularly those in schools taking up Physical Science for the first time.

7.2.5 Characteristics of the Physical Science Students

(a) In terms of mathematics and science backgrounds, Physical Science attracted students with a much wider range of ability and achievement than continued to be the case for Chemistry or Physics.

(b) In both 1978 and 1979, the ratio of boys to girls enrolling in Physical Science in Year 11 was about 1.8:1. The corresponding ratios for Chemistry and Physics enrolments were each about 3:1.

(c) Students enrolling in Physical Science were attracted by the fact that they could combine the study of chemistry and physics in one subject, thus allowing them a wider choice for their remaining subjects. Most also liked the less quantitative focus of the course and the opportunites it gave them to relate science to everyday life.

(d) About sixty percent of Physical Science students in 1978 and 1979 also enrolled in Biology or Human Biology. There was some evidence that the introduction of Physical Science had caused a small drop in enrolments in Chemistry and Physics. However, there was also evidence to indicate that, if Physical Science had not been available, many of those taking the new subject would have chosen a non-science subject in its place.

(e) About fifty-five to sixty percent of incoming students had intentions of continuing to tertiary studies. Of these only a small percentage planned to take courses involving one of the 'pure' sciences, though a substantial number hoped to enter science-related areas such as engineering, computing, agriculture, science teaching and various paramedical fields.

(f) The great majority of students entering the course expressed a 'strong' or 'very strong' interest in science. While they found the subject more difficult in practice than anticipated and generally did not rate it as their most popular subject, they remained highly motivated throughout the two years of the course and satisfied with their decision to undertake it.

(g) From the first cohort of Physical Science the final number to sit for the TAE examination in 1979 was 281. Allowing for the small additional intake of students part-way through the two years, the withdrawal rate was twenty-eight percent, slightly higher than the rate averaged across all two-year upper-school subjects for the State as a whole. A relatively high proportion of the withdrawing students comprised those with weaker entering backgrounds in science and mathematics.

7.2.6 Implementation in the Schools

(a) Most of the schools involved had ample laboratory facilities and equipment and those special items of apparatus and materials required for the course were provided by the Education Department. Technicians were available in almost all the schools and this was an important factor in facilitating the preparation of laboratory activities and materials. One exception to this general picture was the scarcity of electronic equipment for use with two of the optional units.

(b) Library facilities were also adequate in most cases, and teachers commonly established class-libraries for use in conjunction with the student resource books. Ample supplies of

teachers' guides and resource books were available. Some delays were encountered in the production of case-study resource books though this did not appear to hamper the teachers unduly.

(c) Only a few teachers made consistent use of audio-visual aids. One major difficulty concerned the limited access by many teachers to the recommended films, though some schools appeared to be more fortunate or better organised in this regard than were others. There were also problems with the quality and appropriateness of some of the recommended films. Teachers were later assisted to some extent by the production of guidelines on individual films by the Curriculum Branch officers.

(d) Most of the teachers followed closely the structure and suggested sequence of topics within each of the units. They relied very much on the content and suggestions for student activities within the guides. While they encountered problems and difficulties from time to time, most of the teachers found the guides and student resource books to be an indispensible feature of the course.

(e) Though all the teachers in 1978 commenced the year with Materials, Properties and Structures they did not all follow the same sequence through the remaining core and optional units. The majority of teachers chose the options Science and Society and Water and Other Liquids but small numbers used the other available options.

(f) In attempting to cover the content in the manner suggested in the guides most teachers soon found that they were unable to keep to the recommended time schedules. One common problem faced by many teachers was the fact that their students represented a wide range of abilities and backgrounds. Moreover, teachers evidently found it difficult to teach the basic concepts in the less quantitative manner intended.

(g) Both teachers and students relied substantially on the guides and resource books, and many students appeared to have

considerable difficulties in using other science reference books. As a consequence most of the teachers resorted to heavier emphasis on direct teaching and preparation of supplementary notes.

(h) In general, the teachers covered a high proportion of the suggested laboratory activities and demonstrations. Only in a small number of cases did teachers include, in a significant way, class discussion and enquiry approaches; in the main the teaching strategies used were expository. Visits to industrial sites and case-studies were used to provide opportunities for students to engage in related investigation.

(i) Perceptions of the likely content of the first TAE paper in Physical Science played a considerable part in teachers' and students' approaches to the subject. There was natural concern about whether the paper would adequately and properly reflect the broad objectives of the course. In this regard the interaction between the examiners and teachers and the production of a trial paper proved to be valuable to teachers and students.

(j) Some of the teachers commented on the fact that their teaching methods changed significantly during the trial period. Their understanding of the appropriate depth of treatment for particular concepts and of the relationship between various topics within the course developed with increasing familiarity with the course and from interaction and discussion at the in-service meetings. Initial anxieties about the amount of content in the course declined somewhat as the course progressed.

(k) Most teachers used a variety of evaluation procedures as part of their assessment of students. These included periodic written tests, short tests at the end of units, essays, laboratory reports and assignments. There was a tendency in the written tests to focus mainly on chemical and physical principles and factual knowledge along the lines of typical chemistry or physics tests. However, some teachers put

considerable effort into devising examples which stressed applications of science.

(1) The presence in some classes of students who found the course generally too difficult caused anxiety to teachers; however, these students tended to leave the course in Year 11 thereby easing the difficulty for these teachers.

7.2.7 Overall Reactions to the Course and the Written Materials

(a) Considerable interest in the innovation by tertiary scientists was indicated by the variety and strength of reactions to the first trial editions of the guides and resource books. In general the content of the materials and their presentation tended to reinforce previous attitudes, either favourable or unfavourable, towards the course itself.

(b) Aspects of the content of the written materials which generally received favourable comments from a majority of tertiary scientists and consultants included:

- the strong emphasis on laboratory activities integrated throughout the units.
- the many attempts in the materials to relate the science concepts to practical applications in industry and everyday use.
- the inclusion of studies of materials including alloys, ceramics and polymers either in core or optional units.
- the wide range of topics relating to modern applications of science.
- the inclusion of studies of the social impact of technology.

(c) Aspects of the materials which evoked unfavourable reactions included:

- unnecessarily complex treatment of some concepts.

- the choice, in some units, of industrial applications which were either outdated or less relevant than possible alternatives.

- perceived inconsistencies in material used in different units.

- perceived weaknesses in the linking of sections within some of the units.

(d) Many physicists commented on the imbalance of physics and chemistry concepts within the materials and suggested that this required some future modifications.

(e) In general the reactions of Physical Science teachers and students towards the course and the content of the written materials was very favourable throughout the two-year trial period. Aspects of the course which were most attractive to the teachers and students included:

- the opportunity it provided for a broad and integrated study of chemistry and physics.

- the relevance which students perceived the content to have to the world around them.

- its emphasis on interesting practical activities throughout.

- its reduced emphasis on quantitative treatment.

- the opportunities it offered for exploring issues related to the societal implications of science.

- the attractive or interesting content of many of its core and optional units.

(f) Aspects of the course which caused problems to students included:

- the rapidity with which new concepts had to be assimilated in some units.

- the perceived overload in the amount of material to be covered in the scheduled time; this led to some cramming to the detriment of practical activities and discussion strategies.

- the inability of students to obtain an overall picture of some of the content of units; they felt that the content "jumped-around" in some units.

- uncertainty in the interpretation of the stated outcomes in some sections of the course; teachers were unsure about the appropriate depth of treatment for some of these outcomes.

- disappointment among some students (and teachers) at the relative preponderance of chemistry in the course.

- perceived lack of suitable reading material in the resource books; students, on the whole, were not effective in using other science text-books or references.

- relative difficulty of some units e.g. Chemical Change in comparison with others; both students and teachers would have preferred a more consistent level of difficulty across the different units.

(g) Most teachers and students felt that the course was generally quite difficult. Because of the more qualitative approach adopted it was seen as being somewhat easier than Chemistry or Physics but, in other respects, conceptually very challenging.

(h) Teachers made a number of suggestions for improvement of the written material including:

- possible re-structuring of the units so as to incorporate the 'Science and Society' option within core units.

- adoption of a loose-leaf format for the resource books so as to enable students to add further resources.

They also made a wide range of suggestions for minor modifications to the materials (e.g. in relation to outcome statements, guide questions and audio-visual materials).

(i) Among suggestions made by the students for improvement of the resource-books were:

- improved readibility of the supplementary readings.

- clarification of the sequencing within sections of each unit.

- revision of some of the less meaningful laboratory activities.

- additional guidance in relation to the required knowledge and competencies for assessment purposes.

- improvement in the visual presentation of the materials.

(j) While there was naturally continuing interest and at times concern about the form and content of the forthcoming first TAE paper, the general reaction of teachers to the paper, when it was released, was positive. They felt that it was designed in an appropriate fashion to match the overall aims of the course. Some teachers felt that there had been too little emphasis on basic quantitative skills within the questions but this was not a majority view.

7.3 CONCLUDING COMMENTS

The scope of this evaluation study covered the initial two years of the implementation of the new course and did not seek to include subsequent developments. A number of issues relating to the future implementation of the course were raised in comments and discussions by many of those involved at this initial stage. For example, many were of the view that the performance of the first cohort of Physical Science students in their subsequent studies or career choices would be an important determinant of the eventual status and success of the new subject. Interest still remains in relation to the adoption pattern within schools, with particular reference to the major independent schools. Speculations have been raised about the longer-term effects of Physical Science within the school curriculum in relation to enrolment patterns in other science subjects. Suggestions have been made to the effect that some of the innovative teaching approaches incorporated in Physical Science, as well as some of the newer content, may gradually affect the teaching of Chemistry and Physics in the schools. One principal, already dissatisfied by what he perceived as an "elitist" approach in the latter subjects, feared that the innovation would simply reinforce the emphasis on academic theoretical concepts within Chemistry and Physics.

Clearly, two years in the life of a major curriculum innovation of this type is too short a period on which to base final judgments. The implementation of the new course is still at an early formative stage. Nonetheless, it is generally believed by most of those involved that the new course is already firmly established in the system. There is little feeling among participants that the dissemination or implementation processes have faltered in any signficant way. On many of the implementation issues summarised in this chapter, action has already been taken by those concerned to meet difficulties or expressed concerns. Plans are already under way within the Education Department's Curriculum Branch to produce up-dated editions of the teachers' guides and student resource books, taking account of the various evaluation reports of this project as well as a range of other inputs.

However, it is recognised that the next few years will provide a clearer picture of the innovation's eventual success, whether that be measured in terms of adoption rate among schools or in terms of its impact on the nature and quality of science courses in schools. It remains to be seen whether the introduction of the new subject will make a signficant difference to the prevailing patterns of subject choice by the more able group of upper-school students. Finally the pattern of tertiary (and other) careers followed by the first cohort of students to complete the course and their performances in these careers will be watched with considerable interest by those associated with the innovation.

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APPENDIX I

LIST OF REPORTS PRESENTED TO SCHOOLS BY EVALULATION PROJECT

Report on Preliminary Findings from Student Questionnaire No. 1 - Aggregate Data

Report of Preliminary Findings from Student Questinnaire No. 2 - Own Individual School Data (Confidential)

Enrolments in Science Subjects, 1977-78.
(Aggregate Data and Confidential Individual School Figures)

Aggregate Summary of Responses to Teacher Report From No. 1 ("Materials - Properties and Structure")

Aggregate Summary of Responses to Student Questionnaire No. 2 ("Materials - Properties and Structure")

Summary of Responses to Student Questionnaire No. 2 ("Materials - Properties and Structure") Confidential - specific to own individual school.

Characteristics of 1978 Physical Science Student Population

Summary of Responses to Student Questionnaire No. 3 "Chemical Change"

Summary of Responses to Teacher Report Form No. 2 "Chemical Change"

Summary Responses to Teacher Report Form No. 4 "Change and Interaction"

Summary of Responses to Teacher Report Form No. 3 and Student Questionnaire No.4 "Water and Other Liquids"

Summary of Responses to Student Questionnaire No. 5 "Change and Interaction"

Summary of Responses to Teacher Report Form No.1 "Materials - Properties and Structure"

Summary of Responses to Student Questionnaire No. 2 "Materials - Properties and Structure"

Summary of Responses to Teacher Report Form No. 5 "Energy Transformations"

Summary of Responses to Student Questionnaire No. 6 "Energy Transformations"

Summary of Responses to Student Questionnaire No. 7 "Science and Society"

Summary of Responses to Student Questionnaire No. 6 "Carbon Based Materials"

Summary of Responses to Student Questionnaire No. 8 "Carbon Based Materials"

Physical Science Evaluation 1978: Co-operative Research Series

APPENDIX II (a)

STATEMENTS FROM TERTIARY INSTITUTIONS RELATING TO PHYSICAL SCIENCE

Extract from draft statement Murdoch University 26/4/78.

"Physical Science will be accepted by Murdoch University as a T.A.E. subject with the same weighting as Physics and Chemistry.

Students who wish to proceed into the Chemistry, Mineral Science, Biology, Environment Science or Veterinary Biology programmes require a good understanding of Chemistry at the T.A.E. level for entry to a one-semester chemistry course which qualifies them for Part II studies in their programmes. A sound knowledge of T.A.E. Physics would also be an advantage for students entering the Physics, Chemistry, Mineral Science and Environmental Science programmes.

Students who do not have an adequate understanding of Chemistry or Physics at T.A.E. level will have available introductory one-semester courses to give them that understanding before they proceed. A thorough knowledge of appropriate sections of Physical Science will provide an adequate basis for the completion of first year science courses in one year with a reasonable work load".

APPENDIX II (b)

UNIWEST
information for schools

NEW T.A.E. SUBJECT: PHYSICAL SCIENCE

In accepting the new T.A.E. subject, Physical Science, as a full subject for matriculation purposes, the University wishes to make clear its view of the relationship of the new subject to studies in science and science related areas of the University. This viewpoint has emerged from careful considerations in the Departments of Physics and Chemistry and in the Faculties of Science and Engineering, and it also takes into account the needs of other science-oriented Faculties (namely Agriculture, Dental Science and Medicine) in which students are required to take University courses in physics and/or chemistry.

In many courses at the University, teaching assumes certain prior knowledge and experience. For all of the first year physics and chemistry courses it is assumed that students are familiar with the vocabulary and descriptive content, the theoretical content and related calculations and problem solving, and the laboratory techniques of the T.A.E. courses in Physics and Chemistry respectively. These courses are therefore most strongly recommended to any student whose University course will include the further study of physics and/or chemistry. This also includes all students intending to seek admission to the Faculties of Agriculture, Dental Science, Engineering and Medicine. Physical Science, however, may be sufficient for those science students planning to major in Anthropology, Botany, Geography, Human Biology or Psychology provided that their University courses do not include either physics or chemistry. Some recommended courses for Geology and Mathematics majors include studies in physics and/or chemistry while others may be taken without supporting units in these subjects.

It is possible that a student who has performed exceptionally well in the subject Physical Science, and who has the motivation to work particularly hard so as to make up the deficiencies in background, could succeed in a first year chemistry course or in a first year terminating physics course. But this situation should be regarded as exceptional, arising, for example, in the case of a student whose plans and interests have changed since choosing his/her upper school programme.

SUMMARY

As far as this University is concerned the new subject Physical Science should only be taken by students whose primary interests are non-scientific, or who have no interest in entering any science-oriented course which involves studies in physics and/or chemistry.

For further details of course requirements please refer to the booklet "University Courses 1978" or the Faculty Handbooks.

A.J. WILLIAMS
Registrar.

JULY, 1977

APPENDIX II (c)

TERTIARY INSTITUTIONS SERVICE CENTRE
14 Stirling Highway (P.O. Box 55, Nedlands 6009). Telephone 86 2466

Murdoch University
The University of Western Australia
The Western Australian Institute of Technology
The Western Australian Teacher Education Authority

CIRCULAR TO SCHOOLS NO. 6 DATED 14TH SEPTEMBER 1977.

13. PHYSICAL SCIENCE - ADMISSION TO W.A.I.T.

The Western Australian Institute of Technology has requested that the following information relating to the position of the subject Physical Science in connection with admission to tertiary courses at the Institute be circulated to schools:

In accepting the new TAE subject, Physical Science, for admission purposes the WAIT wishes to make clear its view of the relationship of the new subject to tertiary courses in Applied Science and science-related areas of the Institute.

Physical Science does not replace TAE subjects Chemistry or Physics wherever these are specifically stated as prerequisite subjects for entry to certain courses in the Institute.

Physical Science will, however, be an acceptable subject prerequisite for entry to courses where currently it is stated that entrance to those courses requires students to have studied one or more of the science subjects from amongst Physics, Chemistry, Biology or Mathematics.

Prior knowledge and experience in Chemistry and Physics are required for entrance to certain courses of the Institute because it is assumed in those courses that students are familiar with the vocabulary and descriptive content and related calculations and problem solving, and the laboratory techniques of the TAE subjects in Physics and Chemistry respectively. The Institute therefore most strongly recommends that TAE Chemistry and Physics must be taken by students wishing to enrol in such Institute courses.

A student who takes TAE Physical Science and then wishes to enrol in an Institute course requiring TAE Physics and Chemistry as prerequisite studies will be expected to undertake appropriate bridging studies and these may involve studies additional to the normal programmes of students at the WAIT.

Summary

As far as the Institute is concerned, the new subject Physical Science should only be taken by students whose primary interests are non-scientific or those who do not wish to enter a science-based tertiary course which has, as stated prerequisites, either Physics or Chemistry.

For further details of course requirements please refer to the booklet "WAIT COURSES 1978"

APPENDIX III

SAMPLE CALCULATIONS OF INDEX OF DIFFICULTY OF EIGHT UPPER SCHOOL SUBJECTS, RELATIVE TO PHYSICAL SCIENCE

Scores were allocated to the response categories as follows:

Much easier	1
Easier	2
About the same	3
Harder	4
Much harder	5

For each category, the product of the allocated score and percentage of students choosing the category was formed and these products were summed for each subject.

e.g. Biology

$$\begin{aligned} 3.5 \times 1 &= 3.5 \\ 32.8 \times 2 &= 65.6 \\ 48.0 \times 3 &= 144.00 \\ 13.6 \times 4 &= 54.4 \\ 1.4 \times 5 &= 7.0 \\ & \underline{274.5} \end{aligned}$$

This sum was divided by 300, i.e. the corresponding value for Physical Science.

e.g. $\frac{274.5}{300} = 0.9$

This index was derived from ordinal rankings and should be interpreted and used in accordance with this restriction.

12359/5/81—1980—L/3080

WILLIAM C. BROWN, Government Printer, Western Australia